NAA

PENNY RIGG COPPER MILL,

ARCHAEOLOGICAL
COMMUNITY LANDSCAPE
AND BUILDING SURVEY

PENNY RIGG COPPER MILL,
TILBERTHWAITE, CONISTON,
CUMBRIA

prepared for

The Lake District National Park
Authority

NAA 16/145
November 2016
(Issued January 2017)

NAA

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on behalf of

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COMMUNITY ARCHAEOLOGICAL LANDSCAPE
AND BUILDING SURVEY

Summary

Northern Archaeological Associates (NAA) and John Pickin Archaeology (JPA) were commissioned by the Lake District National Park Authority (LDNPA) to work with local volunteers from within the National Park in undertaking an archaeological landscape and building survey of the remains of Penny Rigg copper mill, associated with the 19th-century workings of Tilberthwaite mine, near Coniston, Cumbria. The work was commissioned as part of the Heritage Lottery Fund-sponsored Coniston Copper *project, a two-year scheme aiming to engage local people in the history and conservation of the areas' nationally important mining heritage.*

Penny Rigg copper mill is a prime example of a single-phase, mechanised ore dressing and processing plant. The mine adit – Horse Crag Level – was begun in the late 1840s under the direction of John Barratt, former manager and later share holder of the nearby Coniston copper mine. The aim in driving the new level was to reach the lower levels of Tilberthwaite mine, which had been worked sporadically since the Elizabethan period, but was prone to flooding, making it unprofitable and problematic to operate. The new adit was designed to provide drainage to the mine and to improve transportation of ore from the deep North Vein to the surface for processing. The 1,039 yard (950m) tunnel was scheduled to take seven years to construct at a cost of £3,000, but from the start it was beset with problems, eventually taking 10 years to complete at a cost considerably above initial estimates.

To process ore from the mine, Barratt and his partners invested in the construction of a new copper mill at Penny Rigg, where the ore was to be sorted, crushed and processed before being sent for smelting. Work on the mill probably began c.1864 and was completed in 1867-68. However, it did not remain in operation long and closed soon after the sale of the mine in 1875. The mill re-opened again briefly in the early 1890s, but had closed again by 1892 and was eventually dismantled in 1897, the large water wheel being sold for scrap.

Today, the 1.5ha site comprises the semi-ruinous remains of the crusher house and dressing mill, smithy and powder house, as well as various terraces, two settling ponds, leats, holding pond, spoil tips and tracks, overlain in part by later quarry waste. The entrance to the Horse Crag Level remains visible and the tunnel has recently been cleared by the Cumbria Amenity Trust Mining History Society (CATMHS), although it remains unsafe to access without appropriate equipment and supervision. To the north of the site are the expansive remains of Penny Rigg (Horse Crag) quarry, which was worked commercially since at least the 18th century.

The aim of the community survey was twofold. Firstly, to engage local volunteers in the history and conservation of the site through providing practical, hands-on training, and secondly, to prepare a detailed analytical survey (Historic England Level 2/3) of the surface earthworks and structures to inform a subsequent programme of stabilisation. Topographic, earthwork and building survey were included in the project to provide a comprehensive record of the complex. The focus was on ensuring the volunteers received a firm grounding in traditional survey skills – plane table, tape and offset – which could be easily transferred to other sites. The use of aerial drones, Global Positioning Systems (GPS), reflectorless total station theodolites (REDM), and rectified photography were also demonstrated.

Based on the results of the survey, a series of recommendations has been made to enhance and conserve the exceptional heritage significance of the mill and mine entrance. These include proposals to improve public interpretation of the site and the potential for a phase of targeted community excavation to improve understanding of the construction and operation of the complex. It is also recommended that serious consideration be given to designating the site a Scheduled Monument in order to protect it from any future risks arising from landscape management, quarrying or development.

Acknowledgements

NAA would like to thank all volunteers for their enthusiasm, knowledge and dedication throughout the three-week survey project. NAA is also indebted to Warren Allison, Don Borthwick, Mark Simpson, and Ian Matheson and their colleagues at CATMHS for sharing information and research material, and to the staff at the Cumbrian Record Offices and Armitt Museum and Library for their patience and help. Thanks are due to the Archaeological and Architectural Society of Durham and Northumberland for the loan of their plane table and alidade and to the Barrow Mountaineering Club for use of their facilities. Finally, we owe thanks to Eleanor Kingston and her colleagues at the LDNPA for commissioning the work and for their continued assistance and support throughout the project.

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TILBERTHWAITE, CONISTON, CUMBRIA

COMMUNITY ARCHAEOLOGICAL LANDSCAPE
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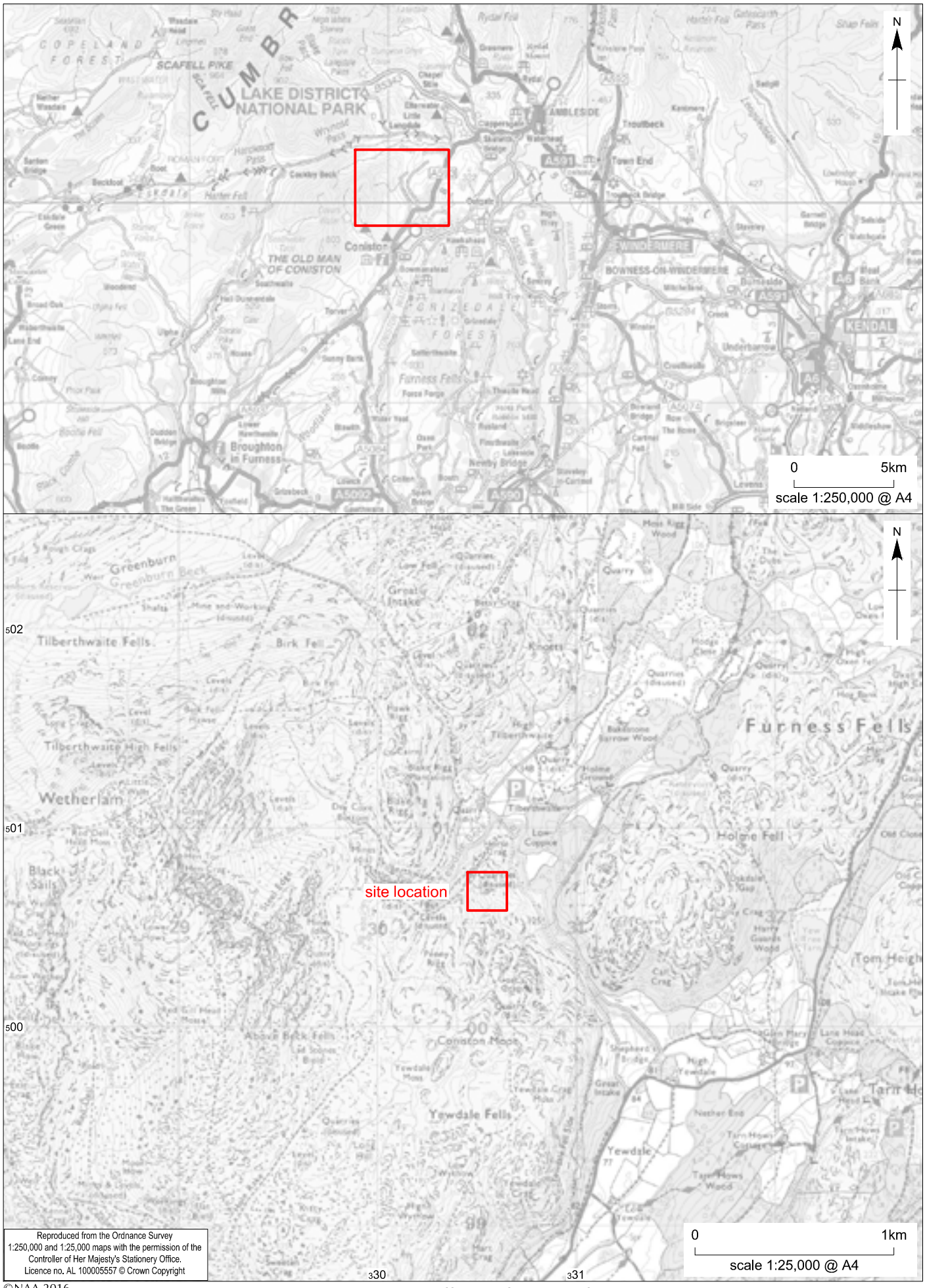


Penny Rigg copper mill, Cumbria: site location *Figure 1*

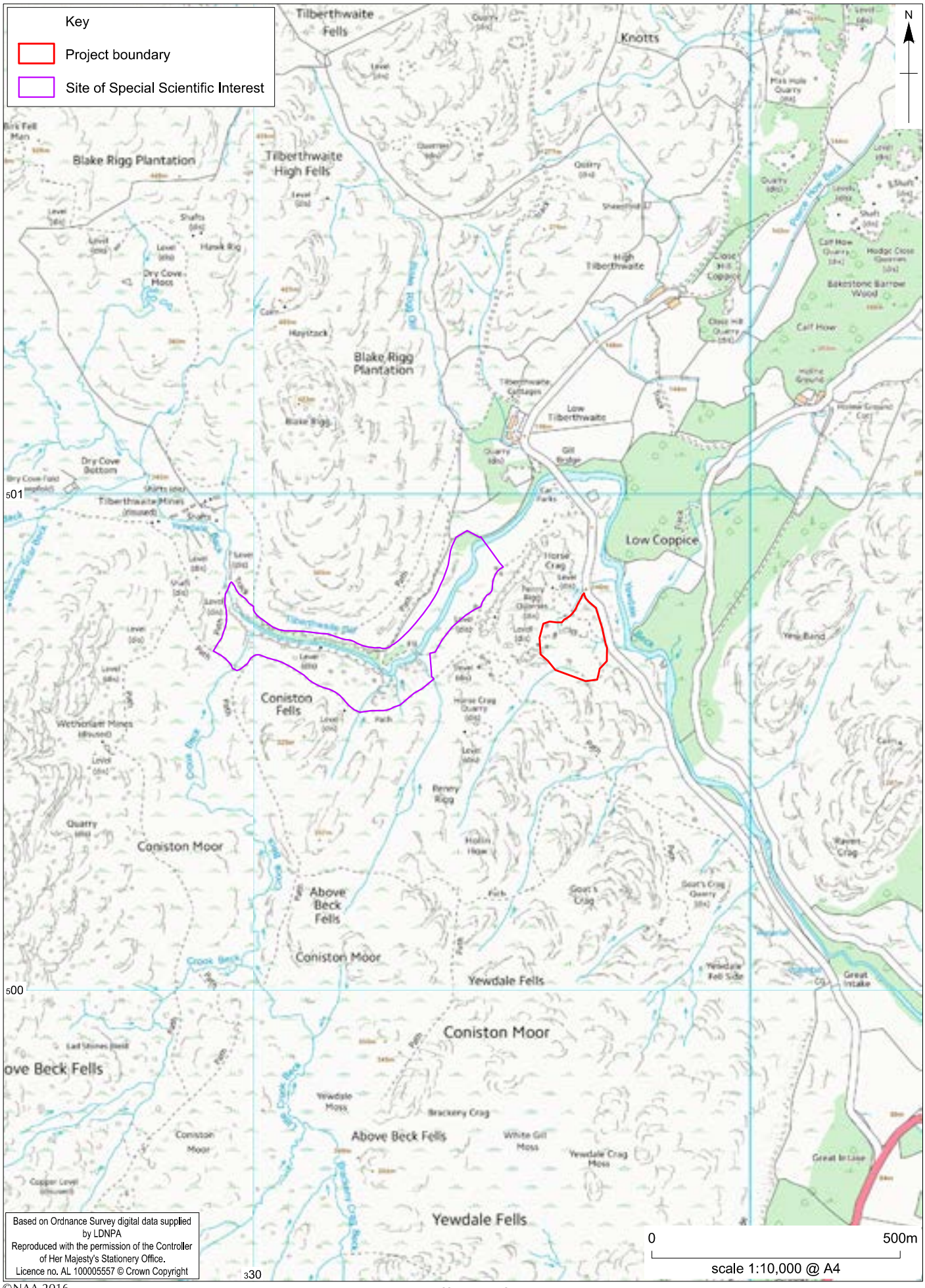
1.0 INTRODUCTION

1.1 Northern Archaeological Associates (NAA) and John Pickin Archaeology (JPA), working together with local volunteers from the Lake District National Park, were commissioned to undertake an archaeological landscape and building survey of the remains of Penny Rigg copper mill (NGR NY 30656, 00695), associated with the 19th-century workings of Tilberthwaite mine, near Coniston (Fig. 1). The work was completed as part of the Heritage Lottery Fund-sponsored *Coniston Copper* project, a two-year project administered by the Lake District National Park Authority (LDNPA), which aims to engage the local community in the history and conservation of the areas' nationally important mining heritage.

Plate 1: *the Penny Rigg copper mill site looking west; photograph taken by aerial drone. Note the rid tips associated with the later slate quarry*

Brief Description

1.2 Penny Rigg copper mill is a prime example of a single-phase, medium-sized, ore dressing and processing plant, and is associated with the 19th-century working of the Tilberthwaite copper mine. The mine adit – Horse Crag Level – was begun in the late 1840s, under the direction of John Barratt, former manager and later shareholder of the nearby Coniston copper mine. The aim in driving the new level was to reach the lower levels of the North Vein at Tilberthwaite mine. The mine had been worked sporadically since the Elizabethan period, but was prone to flooding, making it unprofitable and problematic to work. The new Horse Crag Level was to serve as an adit, providing



Penny Rigg copper mill, Cumbria: project areas *Figure 2*

drainage for the mine, as well as improving transportation of ore to the surface for processing. Work in driving the level was anticipated to take seven years, beginning in 1847, but ultimately took ten years to complete.

1.3 To process ore from the venture, Barratt and his partners invested in the construction of a new copper mill at Penny Rigg, where the ore was to be sorted, crushed and processed before being sent for smelting. The mine and mill remained in production until 1875, when both were sold – along with the Coniston Mine – to Thomas Wynne. It was subsequently worked intermittently until the end of the 19th century, but was never entirely profitable. In 1891, following an extensive roof collapse, the level was abandoned. The then owner of the site, Thomas Warsop, turned his interests instead to slate quarrying, re-opening Penny Rigg quarry in 1892 and starting work on a closehead quarry at the entrance to the level. Finally, in 1897 the copper mill was dismantled, and the waterwheel was sold for scrap.

1.4 In the early 20th century, the mine was briefly re-opened, but closed again in 1933, after which all production at the mine ceased. The quarry continued to operate under the auspices of Oscar Gnosspelius and his agent John W. Shaw until 1938. More recently, in 1989, George Tarr obtained planning permission to re-open the closehead. He continued to work the quarry for a further 10 years until it closed in 2000. There has been no activity at the site since this date, although one of the riving sheds is still intermittently occupied.

1.5 Today, the 1.5ha site comprises the semi-ruinous remains of the crusher and dressing mill, smithy and powder house, as well as various terraces, two settling ponds, leats, spoil tips and tracks. These are overlain in part by extensive tips of quarry waste (rid tips) on the west side of the site. The entrance to Horse Crag Level is still visible and members of the Cumbria Amenity Trust Mining History Society (CATMHS) have recently cleared several blockages from the level interior. To the north of the site are the expansive remains of Penny Rigg (Horse Crag) quarry, worked commercially since the 18th century.

1.6 This document details the results of both the landscape and buildings survey and is intended to facilitate a better understanding of the nature, form, extent, and significance of the surface remains, and to inform the subsequent stabilisation programme. It focuses on the surviving archaeological evidence of the mill, but also considers the mine and quarry in order to place the extant remains in context, and includes: a brief assessment of

the history of the mine and mill; a description of the ore extraction process; an account of the surviving evidence; an assessment of significance; and recommendations for any future work. Finally, it presents an illustrated site inventory of all recorded archaeological features and the contribution of each to the overall significance of the site (Appendix 1).

Project Aims

1.7 The aim of the project was twofold: a) to provide practical, hands-on skills training in topographic and building survey techniques to local volunteers, and b) to prepare a detailed analytical survey of the surface earthworks and structures associated with the former mill. The survey was to be used to inform a subsequent phase of stabilisation and consolidation at the mill, to be carried out by Heritage Consolidation according to a schedule of works provided by Countryside Consultants.

1.8 In achieving this aim, the following objectives, as specified in the project brief (LDNPA 2016), were identified and met:

- a desk-based review of readily available archive and documentary material;
- a topographic/earthwork survey using GPS technology of the wider area (English Heritage 2007, Level 2);
- a plane table survey of the mill and associated features (English Heritage 2007, Level 3);
- a high-level survey of the mill using a quadcoptor or pole camera (Historic England 2015a, Level 3);
- a detailed survey of the individual buildings associated with the site (Historic England 2015b, Level 3/2); and
- production of a suitably detailed and easily accessible illustrated report.

1.9 Local volunteers were involved in all elements of the survey. The main focus was on ensuring a good grounding in traditional survey skills – including plane table, planning frame, tape and offset – which could be easily transferred to the recording of other mining and industrial sites in the area. However, a range of other modern recording techniques were also demonstrated – including the use of aerial drones, reflectorless total station theodolites, and rectified photography – to provide a broader understanding of the various methods which might be used to record complex sites such as Penny Rigg, and some of the limitations of each.

Project Scope and Limitations

1.10 The project comprised an approximate 1.5ha survey area focused on the remains of the 19th-century Penny Rigg copper mill (NGR NY 30656, 00695) (Fig. 2). A 1:200 topographic survey (English Heritage 2007 Level 3) was produced of the mill complex using a plane table. This was extended to the east, beyond the boundary of the project area, to include the remains of the tailing ponds on the west bank of Yewdale Beck. A broader survey (English Heritage 2007 Level 2) outwith the core area was conducted using GPS.

1.11 The building survey was conducted using a combination of offset, reflectorless total station theodolite (often referred to as REDM), and rectified photography (Historic England 2015b Level 3). The survey included the crusher and dressing mill complex and the outlying smithy and powder house. Access to some elements, in particular the wheel pit interior and some of the rid tip areas, was limited due to Health and Safety concerns. Where this was the case, remote survey techniques were used where possible to provide comprehensive coverage.

1.13 The survey was carried out over a three-week period in July 2016 by a team of local volunteers, supervised at all times by NAA staff and John Pickin from JPA (mine specialist). Conditions were generally good, the primary limiting factor being bracken cover, which was high. This caused some visibility issues at the west edge of the site, predominately for the smithy and powder house.

2.0 METHODOLOGY

2.1 All methodologies used were in line with current standards and guidance (English Heritage 2007, 2008; Historic England 2015a, 2015b; Chartered Institute for Archaeologists 2014).

Documentary Survey

2.2 A considerable amount of research has already been undertaken into the history of the mines in the area, much of it by members of CATMHS and the Northern Mines Research Society (NMRS). The existing research has been drawn on throughout this report and is referenced as appropriate, in particular the work of Peter Fleming and Eric Holland. Various individuals were consulted directly, including Warren Allison, Mark Simpson, Don Borthwick, and Ian Matheson, who kindly made available material from their own

personal research, as well as both primary and secondary source material from the CATMHS archive held at the Armitt Library, Ambleside.

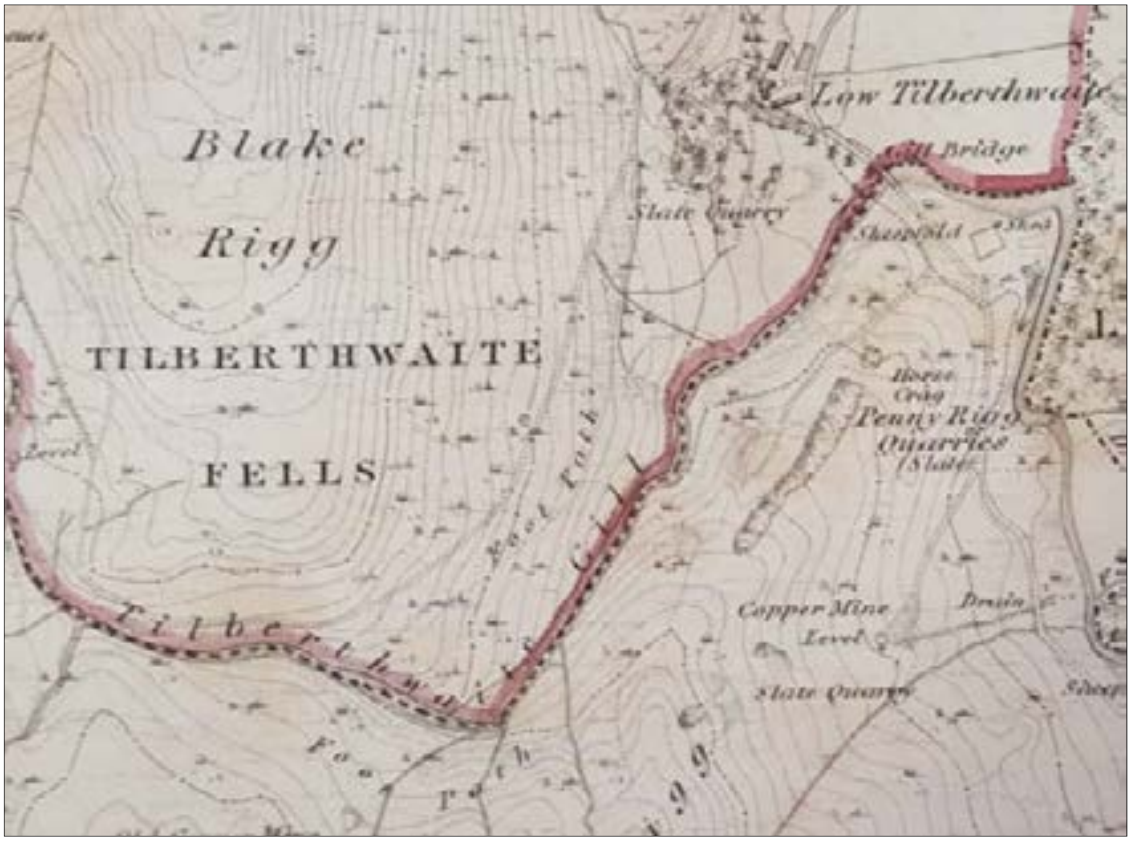


Figure 3: *annotated First Edition 6-inch Ordnance Survey map (1850), showing the division between the Muncaster royalty (Tilberthwaite royalty) north of the Tilberthwaite Gill and the Fleming royalty (Coniston) to the south (WRO DPEN 60/5)*

2.3 Documentary research into the history of Tilberthwaite mine is complicated by a number of factors. Not least, for much of the 19th century both Coniston and Tilberthwaite were operated under the auspices of a single company – the Coniston and Tilberthwaite Mining Company – and the records of the two mines are frequently interlinked, making it difficult to isolate specific references. Tilberthwaite mine also fell under two separate mining royalties[1], the records for Muncaster (Tilberthwaite) being held at Whitehaven record office, and records for Fleming (Coniston) at Kendal.

2.4 Archives potentially relating to the site are dispersed across all four of the Cumbrian County record offices (Whitehaven, Kendal, Barrow and Carlisle), partially because Penny Rigg and Coniston were within the county of Lancashire prior to the local

[1] Royalties are the rights to extract mineral deposits from below ground. They are distinct from land leases which only deal with surface tenancies, although often the two equate.

government boundary revisions of 1974. Within the constraints of the current project, it was not possible to visit all four repositories, but the following archives were reviewed:

- Lake District Historic Environment Record (LDHER)
- Whithaven Record Office (WRO)
- Kendal Record Office (KRO)
- Barrow Record Office (BRO) – online only
- Carlisle Record Office (CRO) – online only
- Public Record Office (PRO) – online only
- Armitt Museum and Library (AML) – CATMHS archive
- The North of England Institute of Mining and Mechanical Engineers (NEIMME)
- British Newspaper Archive (BRN)

2.5 A workshop on undertaking documentary research was conducted during the project, and it is intended that further work might be undertaken by volunteers in the future. To facilitate this, an audit of potentially significant records has been included in the Bibliography.

Archaeological Survey

2.6 The archaeological survey comprised topographic earthwork survey and building recording. Each feature, building, complex or discrete area of space was allocated a unique identification number (context number). These incremented in set blocks – e.g. crusher house (400), dressing mill (500), and any features associated with such elements ascribed a context number in that sequence – e.g. east wall of crusher house (401). A full list of context numbers is included in the Site Inventory at the end of this document.

2.7 A series of control stations was established around the site to ensure that a tight level of dimensional accuracy was maintained throughout, in accordance with Historic England (2015a) guidelines. A local reference system was used initially, but this was later tied into the Ordnance Survey National Grid using an RTK GPS. All heights accord with the Ordnance Survey Newlyn datum.

Interpretative topographic earthwork survey

2.8 A detailed topographic survey (English Heritage 2007 Level 3) was produced at 1:500 scale providing a record of all features associated with the mine complex, including: built structures, water management features, dressing floors, tracks and pathways. The

survey was conducted using a plane table, an alidade and tapes (a disto was tried but proved less successful). The top and bottom (or other pertinent break of slope) of each feature was recorded and hachured by hand on site.

Plate 2: *plane table survey under the watchful eye of John Pickin (adjusting alidade)*

2.9 Elements forming part of the wider context of the mine, including rid and spoil tips, finger dumps, adits and levels, tracks, terraces and watercourses, were surveyed using a sub-centimetre accurate base and rover Topcon differential RTK GPS. This was also used to record the natural topography of the site, to set the mine within its landscape context.

2.10 The survey was further enhanced by the use of a high-level aerial drone (quadcopter). A camera attached to the drone took a series of high-resolution images, which were orthorectified using GPS referenced control points. A Digital Terrain Model (DTM) was subsequently produced and used to inform both the earthwork and buildings survey.

Building Survey

2.11 A detailed record was made of all the standing buildings on the site including the crusher house (400), dressing mill (500), smithy (201), and powder house (220). These were recorded using a combination of plane table, offset, drawing frame, REDM survey, and rectified photography. With the exception of very ephemeral modern features, all

structures were recorded as existing. Structural features of historic significance, such as blocked openings, and fixtures and fittings were recorded and annotated as appropriate.

Plate 3: *volunteers getting to grips with REDM survey – recording points used for rectified photography*

2.12 A photographic record of the site was made using a Canon EOS 5D MkII full frame sensor 21-megapixel camera with 28–200mm 3.5–5.6 zoom lens. All detailed photographs featured a graduated photographic scale of appropriate dimensions. A full catalogue of photographs is included in the site archive.

Plate 4: *traditional building recording techniques – volunteers using tape and offset to record the east wall of the wheel pit*

3.0 BACKGROUND INFORMATION

Location

3.1 Penny Rigg is located on the north-east edge of Coniston, *c.* 3km north of Coniston village. It is separated from Tilberthwaite Fell to the north-west by Tilberthwaite Gill, this is joined at Low Tilberthwaite by Yewdale Beck, which runs along the east side of the site (Fig. 2). The mill is situated *c.* 300m south of the quarry car park, on the west side of the road leading north from the A593 to Tilberthwaite Farm.

3.2 The roughly triangular 1.5ha site was bounded on the east side by the road, although the project area was extended down to Yewdale Beck to investigate a series of earthworks thought to be the remains of tailing ponds associated with the final stages of ore processing. The beck eventually flows into Coniston Water, just north of the village at Robin Wray.

3.3 The south side of the site was defined by the extensive rid tips associated with the later phases of quarrying. These clearly overly the distinct orangery-brown spoil associated

with the mine workings. The north edge of the project area was more fluid, and governed by the visible extent of the buildings, but essentially extended up to the base of Horse Crag. Horse Crag Quarry to the north and west of the site was not included by the survey, neither were any of the mine levels, except in relation to the mill.

3.4 The mill is situated on an east-facing slope, the highest point, at the base of Horse Crag, being 183.08m OD, dropping to 144.43m OD on the road to the south of the mill, and 138.78m OD adjacent to the beck.

Landscape character and land use

3.5 Penny Rigg lies on the south edge of the Cumbrian High Fells District (NCA 8), a landscape characterised by *mountain scenery of open fells and craggy peaks separated by U-shaped valleys with a radiating pattern of rivers and lakes*[2]. The expanse of the open fells is covered by rough grassland, dwarf shrub heaths, peatland, and bracken, with frequent outcropping rock, and screes. This landscape has traditionally provided upland grazing, the soil drained by narrow gills and streams. Off the fells, the more fertile land of the valley bottom features a patchwork of unimproved and semi-improved pasture, punctuated by blocks of woodland. Settlement is clustered in small hamlets and farmsteads, many medieval in origin, although the buildings largely date to the 17th and 18th centuries. Buildings are constructed of local stone, rubble-built with distinctive Coniston green slate roofs.

3.6 Mining and quarrying have traditionally been the key industries of the area and there are numerous disused sites scattered across the fells. Horse Crag Level, the main entrance into the 19th-century Tilberthwaite mine, is located on the west edge of the project area, but there are various other levels shown in the area on the First Edition Ordnance Survey map, published 1850. Tilberthwaite, like Coniston, was first mined under the auspices of the Mines Royal in the 16th century, but was largely abandoned until work recommenced in the mid-19th century.

3.7 The slate industry has been an important part of the region's economy since at least the 18th century; the fine-grained blue-green stone being in much demand as roofing material. There are three historic quarries associated with Penny Rigg, the largest being Horse Crag Quarry, located 160m north-west of the mill.

[2] Citing online reference 'Natural England' < http://publications.naturalengland.org.uk/publication/2229157, accessed 07/09/16

Geology

3.8 The geology of the region comprises rhyolitic and andesite lava flows, inter-bedded with hardened volcaniclastic dust and ashes of the Ordovician Borrowdale Volcanic Group, formed roughly 450 million years ago (Holland 1981; Adams 1988; Fleming 2007). Subsequent tectonic activity resulted in folding and tilting of the sequence, forming cleaves and faults. Cleaving is most clearly manifest in the numerous slate deposits across the fells, while the faulting resulted in the formation of mineral-rich subterranean fissures, concentrated and transported by hydrothermal fluids. These fissures – or veins – contain a complex mixture of different minerals including copper, lead, zinc and a variety of other metals. Miners have divided the mineral-rich deposits into two groups: ore, and gangue. The latter comprised a range of minerals considered to be commercially worthless at the time, including quartz, baryte, fluorite, and calcite. The primary suite of minerals found at Tilberthwaite is chalcopyrite, arsenopyrite, and iron pyrites

Copper

3.9 The principal copper ore is a brass-yellow chalcopyrite, a copper iron sulphide ($CuFeS_2$). This is found occasionally in a pure state, but is more generally mixed with gangue, necessitating crushing and dressing to extract the copper (Holland 1981; Adams 1998). Where the mineral content was high, or the enterprise small, this was sometimes undertaken by hand, but more generally the process was mechanised and copper mills, such as that at Penny Rigg, were built to sort, crush and filter the raw mineral, leaving a copper concentrate ready for smelting.

Slate

3.10 The slate worked in the area comprises part of the Borrowdale series of fine volcanic dust and ash. This has a distinct blue-green hue resulting from the high percentage of ferrous oxide in the stone (Davies-Shiel & Marshall 1969, 154). The colour of the slate, together with its non-porous and non-staining properties, contributed considerably to the popularity of the stone for roofing across the north of England in the 18th and early 19th centuries.

Designations

3.11 The mill and associated mining remains and quarries are not protected by any statutory heritage designations. The site was reviewed by English Heritage in 1995 as part of Stage Three Monument Protection Programme assessment of the copper industry (HER 3151). At that time, the national importance of the complex was commented on, but no

recommended for designation was made.

3.12 The complex is listed as a non-designated heritage asset on the LDNPA Historic Environment Record (HER 5608), considered of particular significance in terms of the history and development of the region's copper mining industry. The adjacent Penny Rigg slate quarries are also recorded (HER 18493). Non-designated heritage assets are afforded some protection in planning policy. Paragraph 135 of *National Planning Policy Framework* (Department for Communities and Local Government 2012) states that: *the effect of an application on the significance of a non-designated heritage asset should be taken into account in determining the application. In weighing applications that affect directly or indirectly non-designated heritage assets, a balanced judgement will be required having regard to scale of any harm or loss and the significance of the heritage asset*.

Figure 4: *location of Tilberthwaite Gill SSSI, (information from DEFRA MAGIC [3])*

3.13 Approximately 200m north-west of the mill is the Tilberthwaite Gill Site of Special Scientific Interest (SSSI), protected under the Wildlife and Countryside Act 1987 as amended by the Countryside and Rights of Way Act 2000.

[3] citing online reference 'MAGIC' http://magic.defra.gov.uk/MagicMap.aspx, accessed 13/09/16

Previous Work

3.14 In 1999, a measured survey of the mill was undertaken by members of CATMHS (D. Borthwick *pers. comm.*). This survey only came to light relatively late in the current project, but has provided a useful baseline reference and helped to assess levels of deterioration across the site over the past 17 years. A copy has been included as Appendix 2. Members of CATMHS have also undertaken research into the history and development of the mine and mill complex, most notably Peter Fleming, Warren Allison, Ian Matheson, Don Borthwick, and Eric Holland. Holland includes a sketch plan of the mill in *Coniston Copper Mines: A Field Guide* (1981, 75).

3.15 In 2010, a Conservation Management Plan of the mill, levels, and slate quarry was prepared by Archaeo-Environment (2010). This is referred to throughout the text and cross-referenced as appropriate. The document included a site inventory of key features and recommended further conditions assessment, and a detailed measured survey.

3.16 In 2012, Countryside Consultants undertook a full conditions assessment of the mill, including the preparation of a detailed sketch plan of the complex. The assessment culminated in a schedule of works for the stabilisation and conservation of the property, due to begin in 2017. The current survey is intended to further inform and facilitate these works.

Ownership

3.17 The site is owned by the Le Fleming family and forms part of the Rydal Estates, administered by Carter Jonas LLP of Kendal.

Glossary

3.18 Technical terms are included in a glossary at the end of this document (Appendix 3).

4.0 HISTORY AND DEVELOPMENT OF THE MINE AND MILL

Early Development of the Copper Industry

4.1 Copper ores have been mined in the British Isles since the Bronze Age (*c.* 2300 – 700BC), with sites dating to this period identified in southern Ireland, central and north Wales, and the English Midlands. However, it was not until the mid-16th century, and the formation of the Mines Royal under Elizabeth I, that the foundations of the modern industry were laid (Archaeo-Environment 2010, 17).

4.2 The Society of the Mines Royal was set up under royal charter in 1564 to *'search, dig, roast and melt all manner of ores of gold, silver, copper and quicksilver'* in the counties of York, Lancaster, Cumberland, Westmorland, Cornwall, Devon, Gloucester, Worcester and Wales (Bond & Price 2005, 200). It was one of two mining monopolies, the other being the Company of Mineral and Battery Works, set up with the intention of developing Britain's metal industries and making the country less dependent on foreign imports. This was particularly important in times of war when various metals were essential in the production of ordnance and ships.

4.3 The directors of the company, which included Sir William Cecil, the Secretary of State, and Robert Dudley, Earl of Leicester, invited a group of mining experts from Germany, led by Daniel Hechstetter (sometimes Hochstetter) to oversee the search, extraction and smelting of copper and other ores in Cumberland, Westmorland and Lancashire (Fleming 2007, 1). Hechstetter was an agent of the Haug Company, a successful consortium of merchants that had established links with London. Under the auspices of the Mines Royal, he established a number of mines across the area, including Tilberthwaite, known to have been in production by the late 16th century.

4.4 The mine was located at the head of Tilberthwaite Gill, *c.* 0.8km north-west of Penny Rigg, on land now managed by the National Trust (NT HER 20111/MNA119493). Ore from the Elizabethan mines was transported by packhorse across the fells and brought to the smelter on the Greta River at Brigham, near Keswick (Archaeo-Environment 2010, 17).

4.5 However, by the early 17th century, the Mines Royal copper mines were already in decline, the company shifting focus instead to more profitable lead mines. In a survey of mines commissioned by the Crown in 1599, both Tilberthwaite and Coniston were

described as being in poor condition with dilapidated workings (Holland 1986, 24). By the mid-17th century, production had ceased altogether, as cheap supplies of Swedish copper began to dominate the European metals markets. In contrast, there was a huge expansion of the local slate industry during this period, to meet the increasing demand generated by the 'great rebuilding' of houses and cottages in stone.

The 18th Century – Revival of the Industry

4.6 The passing of the Mines Royal Act in 1689 finally ended the royal monopoly on metals and saw new, private investment in the copper mining industries of Devon and Cornwall, and South Wales, and opening of new mines in Staffordshire and Cheshire. In the North West, the principal mines worked at this time were Roughton Gill (Caldbeck), Goldscope (Newlands Valley), and Coniston, the latter being reopened by the Macclesfield Copper Company under Charles Roe in 1758.

4.7 At Tilberthwaite, Anthony Tissington of Alfreton in Derbyshire is recorded as leasing the mine in 1759 (Bouch & Jones1961, 255), and there is further documentary evidence to suggest that there was small-scale production throughout the 18th century. This was latterly on an intermittent basis and sometimes without the permission of the landowner (NT HER 20111). However, by the end of the century, the mine was in a very poor condition, with much of the underground working in a state of semi-collapse and prone to flooding (Adams 1988, 151).

4.8 Towards the end of the century, there was a marked increase nationally in the demand for copper. In the 1750s, the Royal Navy had begun to experiment with copper-bottoming ships, that is the application of a copper sheath to the keel and hull of a vessel to inhibit the growth of weed and prevent worm infestation. Following the success of the trials, the Navy Board made the decision to implement the process across the entire fleet, beginning in 1789. With an estimated 14 tons of metal required to copper a 74-gun ship of the line, this resulted in considerable increase in the demand for copper ore. The upturn in the market corresponded with the discovery of a 'Great Lode' at Parys Mountain in Anglesey, also owned by Charles Roe, which flooded the British market with cheap copper, culminating in the decline and eventual cessation of operations at Coniston.

The 19th Century – renewed investment and expansion at Tilberthwaite

4.9 The 1814 Board of Agriculture report on Lancashire, prepared by Dickinson, makes reference to three copper mines in operation in the county: *'The oldest mine is at Coniston; there is another at Muckle Gill, a little more to the north-east, which has been established about five years. At Hartriggs, a little higher up in these hilly ranges, a still richer ore of this sort has been discovered, but not in sufficient wrought with profit'* (Dickinson 1814, 69). Muckle Gill runs adjacent to the mine at Tilberthwaite, and it is notable that this extract refers to work starting at the site five years previous; i.e. *c.* 1809. The article further states that ore from Muckle Gill was sorted by hand and processed on site using a water-powered stamp mill before being sent to Messrs Watkin, Borrow and Atkinson at Cheadale in Staffordshire for smelting. The resulting metal was used primarily in the production of wire and copper-bottoming ships (Dickinson 1814, 70; Corry 1825, 135).

4.10 A few years after the publication of Dickinson's report, John Taylor took out a 21-year lease on the copper mines at Coniston, signed on the 24th September 1824 (Holland 1986). Previously, the mines had been described in the Board of Agriculture report as being *'at present very poor in metal'* (Dickinson 1814, 69). As an engineer and agent, Taylor had extensive experience of metal mining, first at Wheal Friendship (Mary Tavy) copper mine near Tavistock in Devon and then in Flintshire as mineral agent to the Lord Governor. In 1818, he accepted a new position as mine agent to the Duke of Devonshire, managing the lead mines at Ecton Hill (Staffordshire) and Grassington Moor (Yorkshire).

4.11 Production at Grassington had been suspended for a number of years prior to Taylor's appointment, primarily due to flooding. Taylor immediately set about the erection of pumping equipment, driven by a 50ft wheel. To assist him in this enterprise, Taylor employed the services of the mining engineer John Barratt, who he had first worked with at Wheal Friendship in Devon. The two men transformed operations at Grassington, installing complex systems of power transmission and importing Cornish stamping and crushing machinery, together with mechanised jigs and buddles. They also laid miles of connecting railway lines to improve transportation. The implementation of these improvements were largely responsible for the substantial increase in output during the second quarter of the 19th century, and the return of the mine to profitability (Burt 1977, 27).

4.12 Taylor and Barratt then turned their attention to implementing a similar system at Coniston, bringing the failing mine back into production and prosperity (Burt 1977). By 1850, as a result of their endeavours, Coniston was producing in the region of 3,000 tons of ore per month and employing more than 600 people. The massive site covered both sides of the valley, extending from Paddy End to Red Dell, and featuring 13 waterwheels transferring power to three dressing mills, as well as various pumps, winches, and mechanised jigs and buddles (Holland 1986).

The first phase of development at Penny Rigg – 1849 – 1975

4.13 Taylor resigned from the company in 1841, selling his remaining shares to Barratt the following year. With Coniston in profit, the remaining partners – John Barratt of Church Coniston, Joseph Mason of Grassington, and James Hambleton of Asbourne in Derbyshire – turned their attentions to Tilberthwaite mine, forming the Coniston and Tilberthwaite Mining Company (Adams 1988, 147). On August 1st 1849, the three signed a lease agreement, countersigned by Dame Ann Frederica Fleming, securing the Fleming (Coniston) royalties on Tilberthwaite for a period of 30 years, at a rate of 1/15th of the overall annual return. This is referenced in a later Abstract of Title of the Trustees, dated 1875 (AMATL 2016.687).

4.14 The agreement makes mention *of 'all houses, buildings and other enclosures there erected and set up in and upon the said premise respected for the purpose of work of the said mines'*, but makes no direct reference to any specific buildings, such as the crusher house or dressing mill (Adams 1988). It does state that the leasee may *'erect, construct, set up, repair, maintain and continue any smelt house, stone houses, bing steads, smithies, forges, workshops, mill, pumps, gin and other buildings steam or other engine machines'* [author's punctuation], but such wording is generic to most royalty agreements and does not necessarily imply agreed expansion plans. Similarly, the document continues, that the partners and '*miner's agents, servants and workmen for such purposes as to open and sink, drive, dig, work and make any shafts, drifts, cross-cuts, sumps, pits and adits, and to win, raise, get up, work , stamps, buddles, wash, clean, make merchandisable, smelt, run down, refine and keep the said mineral ores and other matters'*, [author's punctuation].

4.15 Prior to 1841, the Tilberthwaite mine was being worked by Michaeol Knott. Knott lived in Monk Coniston, was a shareholder at Newland Furnace and had mining interests in the Isle of Man. Barratt first mentions Knott in a letter dated 31st November 1823, in

regard to the potential purchase of the mine, and he continues to appear in the correspondence from 1823 to 1830 (AMATL 2016.887; I. Matheson *pers. comm.*). Subsequent tenants associated with the Fleming royalty are recorded in the abstract at the end of the 1841 tenancy (AMATL 2016.687) and include:

1834 – indenture signed between George Jackson, William Tyson and Margaret Bownas on the one part, and Issac Brown on the other part;

1840 – indenture between numerous members of the Tyson family, Sarah Pollitt, Thomas Gailskill and his wife, and John Bownas;

1840 – indenture between John Bownas, Thomas Barrow and John Barratt.

Working the New Mine

4.16 In order to make the mine viable, Barratt and his partners planned to drive a new adit north-west from Penny Rigg to connect with a group of veins at the head of Muckle Gill, upstream from the waterfall on Tilberthwaite Gill. The aim of this was twofold: first to provide drainage to the existing workings, and second to improve transportation of material out of the mine. Ore would be moved via shafts from the upper levels to the adit – referred to as Deep Adit or Horse Crag Level (101) – to a newly constructed dressing mill at Penny Rigg.

4.17 The aim was to drive the new level beneath the existing workings at a depth of 525ft (125m), to intersect the principal vein – the North Lode – at Muckle Gill. This was scheduled to take seven years at an estimated cost of £3,000, but from the very beginning the project was beset with problems. Ultimately, the 1,039yd (950m) tunnel took 10 years to complete at an unspecified cost (Holland 1986, 143).

4.18 The adit crossed beneath Tilberthwaite Gill, the division between the Fleming (Coniston) and Muncaster (Tilberthwaite) royalties. Therefore, the company needed to secure a separate royalty agreement with the Pennington family, Lords of Muncaster, in order to complete the works. There is a draft indenture in the Whitehaven record office, drawn up in 1845 between Frances Catherine, Lady Muncaster, on behalf of her son, James Augustus Pennington, and the three partners, Barratt, Mason and Hambleton (WRO D/PEN 16/90). The indenture was amended on the 10th August 1853, presumably when Lord Muncaster came of age; the original date and his mother's name are both crossed out. However, it is unclear if this document was ever finalised. The first signed indenture in the archive dates to 1864 (WRO DPEN/137/1/1/5).

4.19 The details of the draft document are very similar to those of the earlier Fleming indenture (although the rate is slightly lower at 1/18th of the annual return). Notably, the document also conveys the right to *'all minerals and other matters'* but not to slate. Corry, writing in 1825, refers to the *'excellent blue slate'* extracted from the Tilberthwaite quarries, stating that at *'Penny-Rigg the slate is conveyed on trucks through a level drain into the side of the rock, at some height above the bottom of the pit. Each quarryman can raise a ton per day, for which he is paid from 2s 6d. to 3s 6d according to the quality of the slate'* (Corry 1825, 528).

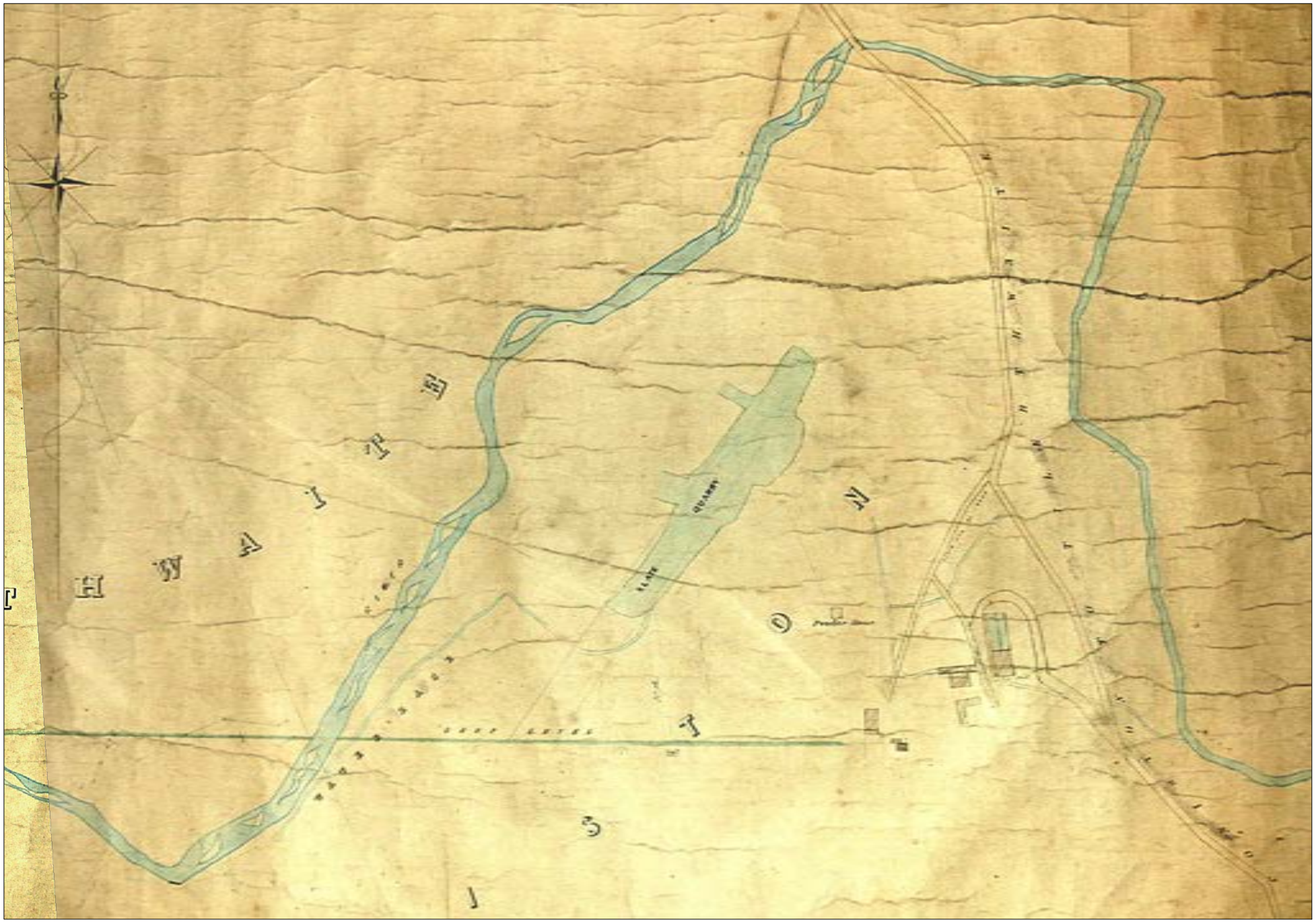
4.20 The First Edition 6-inch Ordnance Survey map (Fig. 5), surveyed in 1848 but not published until 1850, shows work on Horse Crag Level already underway – marked 'Copper Mine Level'. However, the mill and processing works have clearly not been constructed at this time.

Figure 5: *extract from First Edition 6-inch Lancashire and Furness Ordnance Survey map, surveyed 1848, published 1850*

4.21 In 1862, just six men are recorded in the Kinnaird Commission report on the condition of mines as working at Tilberthwaite. This compares to 335 listed for Coniston (Holland 1986, 153). Two years later, on the 4th July 1864, the company signed a new lease on the Muncaster royalty (it is unclear if the 1853 indenture was ever finalised) (WRO DPEN/137/1/1/5). The indenture was signed by the guardians of Margaret Swan Elizabeth Pennington, an infant at the time, and John Barratt, Joseph Mason and a new partner, John Cruso of Leek in Staffordshire. The details of the lease are similar to those of the earlier agreement and there were still no direct references to the mill or crusher.

Figure 6: *extract from notebook of materials dating to November 1866, recording the delivery of the mill wheel (AMATL 2016.881)*

4.22 The construction of the new mill at Penny Rigg probably began soon after the 1864 lease was signed. Prior to its completion, ore from Tilberthwaite was transported to the Bonsor dressing floors at Coniston for processing (Holland 1986, 161). Entries in a notebook of materials received at Coniston and Tilberthwaite mines suggest that the building was well underway by September 1865 when two *'sifter bottoms'* were delivered for the new mill (AMATL 2016.881), together with *'1 small wheel,* 2 *chairs for levers in mill, and 1wheel step'*; the latter all from *'E Salmon'*, the foundry at Ulverston (later Salmon, Barnes & Co.). In July the following year (1866), the foundry delivered to Tilberthwaite 8 small brass steps, 12 brackets, 5 levers and 5 cases, as well as 37 rail chairs, and two months later, in November 1866, '*one big wheel for the mill'* and *'one brass for mill'*.



Penny Rigg copper mill, Cumbria: detail from the Lampton plan c.1869

Figure 7

Interestingly, on the 27th November, 24 stamp plates and 1 Ash tree were delivered, ordered from 'Mr Barratt', suggesting there was a stamp operating at the site (unless the mill at Muckle Gill was still in operation).

4.23 In May the following year, a series of jigging frames, as well as bearing brackets and couplings, were ordered from the Ulverston foundry, but after this date there are few such references, suggesting the dressing mill was complete. Later entries relate to the maintenance of the complex, including an order for a further 12 stamp heads in 1876. Orders for powder were also signficntly lower by this period, reduced by over one half of that consumed in the 1860s, all of which would suggest that the level was complete and the mine 'up' and in full production by this date.

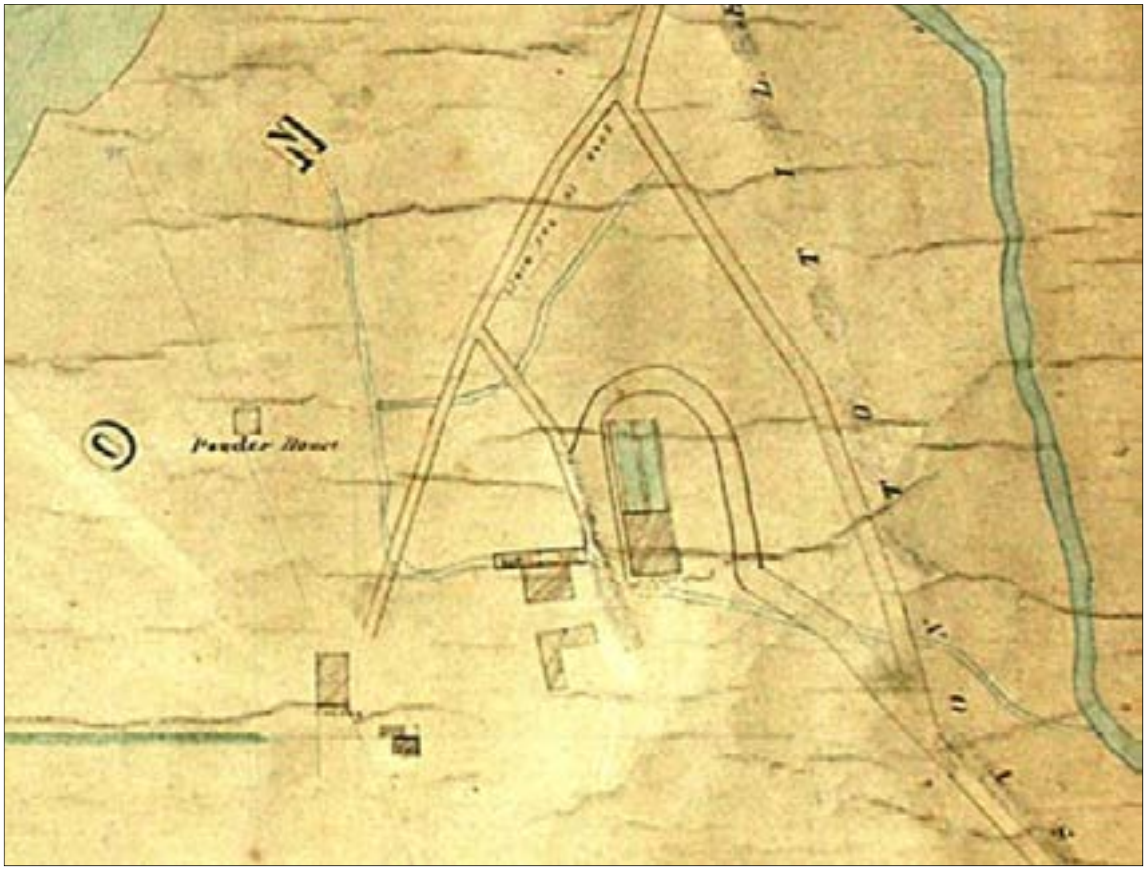


Figure 8: *extract from the Lampton map,* c. *1869, showing the dressing mill complex (CATMHS archive – no ref – image supplied by I. Matheson)*

4.24 The completed mill complex is shown on the Lampton Estate map, prepared *c.* 1869 (CATMHS archive, no ref) (Fig. 7), the layout of which is much as it appears today. The only exception is the L-shaped structure to the south of the crusher, which is now largely buried beneath a later rid tip (813), although a small section of paved floor still survives

in situ (423). The plan also shows a small rectangular structure to the east of the level entrance, which may be an ore hopper (Fig. 8).

4.25 The Lampton map suggests that water to power the large mill wheel was diverted from Tilberthwaite Gill and conveyed along a curving leat to Penny Rigg (Horse Crag) quarry (Figs 7, 8). A small dam is shown controlling the flow into the race from the gill at approximately NY 30283, 00642. The diverted water flooded the quarry, where all production had ceased a number of years earlier, effectively creating a reservoir. Water was carried along the old quarry adit, mentioned by Corry, and fed into the mill leat (Corry 1825, 528). The location of the quarry on the higher ground to the north of the mill would have ensured a suitable head of water was maintained at all times.

4.26 By January 1867, at least 18 men were recorded working at Tilberthwaite mine, suggesting that possibly the adit had been completed by this date. There are also references in the mine daybook to tutwork (piecework) being undertaken at Tilberthwaite in 1871 (AMATL 2016.888). The first record of copper ore output from Tilberthwaite appears in 1874, when it is included together in the overall returns for Coniston. In the same year, the Coniston and Tilberthwaite Mining Company Ltd. was registered for the first time with the Board of Trade Companies Registration Office (PRO BT 31/1949/8188). However, the company was to prove short-lived. By the early 1870s, the British copper industry was in decline, the price of copper having fallen considerably in the wake of the discovery of huge mineral deposits in Chile, Australia and North America. In 1854, 3,048 tons of copper ore had been produced at Coniston, falling to 1,897 tons in 1864. In 1873, the figure continued to decline to 1,392 tons, despite the addition of Tilberthwaite, and a year later fell to just 935 tons (Holland 1986, 162 – citing T. Eastwood's treatise on mines).

4.27 By 1874, all three of the original partners in the company were dead. John Barratt died on the 14th April 1866, Humbleton sometime before this, and Joseph Mason on the 14th October 1868 (AMATL 2016.687). William Barratt replaced his father as Chairman of the Board, but by early 1875, faced with high maintenance costs, falling returns, and a deepening financial crisis, the difficult decision was made to sell the mines (AMATL 2016.801, letter dated 2nd June 1875).

4.28 The *'well known Coniston and Tilberthwaite Copper Mines in North Lancashire'*, were auctioned at the Clarence Hotel, Manchester on Tuesday 3rd August, 1875 by Messrs

T.M. Fisher Sons & Co. (1875 sales flyer – provided by W. Allison).

> *The Tilberthwaite Royalty comprises a large area adjoining Coniston, the deep level has been driven 1000yards, and underwaters a large district, one lode only has been partially opened on, there are three other lodes in short distance, and there is no doubt large returns will be made from this Mine. There is also a vein of Slate rock of good quality near the level mouth, for which offers to work have recently been made. The supply of water here is most ample.*
>
> *These Mines are held on lease of which ten years are unexpired, at a minimum rent of £60 merging into a Royalty of 1/15th.*
>
> *The Copper Station at the terminus of the Coniston Branch of the Furness Railway is within three-quarters of a mile of the principal dressing floors, rendering easy access to and from the Mines.*
>
> *The whole Machinery and Buildings are in good order and repair.*
>
> Coniston and Tilberthwaite Mines Sale Notice 1875

4.29 Tilberthwaite never returned the huge investment made by Barratt and partners in driving Horse Crag Level and constructing the mill; a fact alluded to in a rather bitter statement at the end of the sales document *'A very considerable sum has been laid out in opening the Mines, of which the Purchaser would reap the advantage'.*

4.30 An earlier draft of the sale notice (WRO DPEN 46/102-106) provides further details of the complex listed as including a '*mill house, smith's shop, copper shed, and shedding for workers for the plant,'* as well as 2 large waterwheels (12 and 32ft diameter), new crushing mill with revolving screens, jigging machines, and waggons.

Thomas Wynne and a period of decline – 1875-1891

4.31 Both Coniston and Tilberthwaite were purchased by Thomas Wynne of Staffordshire, an H.M. Inspectors of Mines and previous shareholder in the Coniston and Tilberthwaite Mining Company Ltd[4]. Tilberthwaite was dropped from the name, the company afterwards being referred to as the Coniston Mining Company.

[4] Wynne is listed as a trustee in a letter dated 2nd June 1875 (AMATL ALM 2016.800)

4.32 Wynne appointed William Bawden as agent and Bennett Johns as purser (Holland 1986, 173) and on the 31st March 1877, signed a new 21-year lease on the Fleming (Coniston) Royalty (cited in WRO DPEN 137/3/3/26). This was followed two years later by the same agreement on the Muncaster Royalty, signed on the 28th March 1878 (WRO DPEN 60/9). Both were set at 1/40th share, plus a rent of £5 per year. Despite negotiating the new leases, Wynne appears to have shown little interest initially in Tilberthwaite, concentrating his investment instead at Coniston, and the mine remained largely un-worked over the next few years, the mill falling into disrepair.

4.33 In early 1883, a prospective buyer, Mr Watson, expressed an interest in purchasing Tilberthwaite, which Wynne intimated he might be willing to sell. In anticipation of a visit by Watson, Bennett Johns sent William Hellen to begin clearing the Horse Crag Level of fallen debris (Holland 1986, 184). Hellen reported that the level was driven through very faulted ground in some areas and liable to collapse unless new timber props were installed. The above ground conditions were little better. In June of the same year, the company were fined £10 for the use of an *'unlicensed and unsatisfactory'* powder store at Tilberthwaite (Holland 1986, 185). In the end, Watson did not pursue the purchase, undoubtedly deterred by the unfavourable reports. However, the level was successfully cleared and reopened, and remained in operation for three years, until a substantial roof collapse in 1886 (Cameron 2010, 1).

4.34 In the same year, Thomas Cook, a mine inspector from Dalton-in-Furness, was sent to assess the condition of both Coniston and Tilberthwaite mines. He reported that while the condition of Tilberthwaite was poor, the sett itself *'showed a promising appearance and was worth securing'* (Holland 1986, 202). Cook later qualified this statement in a letter sent to his friend John Birkett, a local slate merchant, on the 13th October 1866. Birkett had expressed an interest in purchasing the mine but was advised by Cook that, given the depressed state of the current market, the return on the sett would probably not be sufficient to warrant the expenditure required to bring the site back into production (Holland 1986, 202).

4.35 The failure of yet another potential sale led Wynne to comment in a letter to a friend *'the mines are such a dead weight on my hands, and it is a difficult matter to make ends meet'* (Holland 1986, 202). However, finally, in 1889, he did secure a buyer, and following two years of heated negotiation Wynne sold the mine to James Fleming for an undisclosed sum. Fleming intended to re-open Horse Crag Level and bring the mine back

into production. To this end, he immediately began work on clearing the tunnel collapse, but his plans were soon thwarted when he discovered that under the terms of sale he had actually only purchased the rights to the Coniston Royalty. This meant that of the 500 fathoms that constituted the mine, James Fleming could only access the first 130 fathoms. The rest formed part of the neighbouring Muncaster Royalty, retained rather duplicitously by Wynne.

4.36 In a letter dated the 9th April 1889, Fleming's agent wrote to Rydal Hall that Wynne had the power to:

'*keep these two manors locked up to the exclusion of others who are willing to work them and at the same time to allow the level on which so much money and labour were expended to fall to ruin. Mr Wynne has be the curse of the place ever since he came'* (WRO D/PEN 132/2/3/1).

Figure 9: *extract from Second Edition 6-inch Lancashire and Furness Ordnance Survey map, published 1891-1892*

4.37 In an attempt to break the stalemate, James Fleming insisted that a mining engineer be commissioned to inspect the condition of Horse Crag Level, because under the terms of the Muncaster lease, Wynne was required to maintain the workings and machinery in good order or risk forfeiture (Holland 1986, 205). In the meantime, despite all obstacles, Fleming continued to invest in Tilberthwaite, installing new plant in February 1889 (Holland 1986, 205). However, by late June, work had reached a standstill. Meanwhile

Wynne, recognising that the future of copper mining was bleak, instead turned his attentions to re-opening Penny Rigg slate quarry (on the Muncaster Royalty) in an attempt to recoup his losses.

4.38 In the same year (1889), copper prices reached an all time low, primarily due to the influx of cheap copper from Chile onto the British market. Two years later, in 1891, Wynne finally relinquished his shares in both Coniston and Tilberthwaite to Thomas Warsop. Warsop was an engineer and entrepreneur who had initially become involved with Coniston in 1883 as a specialist in air-compressed drilling. He had remained an influential figure in the subsequent development of Coniston, working together with his partner Charles Edwin Day, in an attempt to restore the failing fortunes of the mine. In 1892, Warsop re-opened Penny Rigg (Horse Crag) quarry, and in so doing marked the end of the copper mill.

4.39 The mill is marked 'Copper Mill' on the Second Edition 6-inch Lancashire and Furness Ordnance Survey map, produced in 1891-92, just before the expansion of the quarry (Fig. 9). The layout of the mill complex is shown much as it appears on the earlier Lampton map (Figs 6, 7). All elements are shown as roofed and potentially in working order. In 1897, the plant and machinery were finally dismantled and the 30ft diameter 'Crushing Mill Wheel' sold as scrap for £3 (AMATL 2016.800).

The 20th Century

4.40 In the early 20th century, production at the mine resumed for a brief period between 1912 and 1913, when the sett was worked by the Central Chile Copper Company, but the dressing mill and crusher remained abandoned and are marked as 'disused' on the Third Edition 25-inch Ordnance Survey map, published just before the First World War in 1914 (Fig. 10). The map clearly shows the extent of the quarry workings by this time, in particular the spread of the rid tips, which cover large parts of the former mill site. One of the most notable changes is the opening of the closehead quarry at the mouth of Horse Crag Level, and the associated rail lines that had been laid. The track runs east from the closehead and then separates, one line transporting waste material to the rid tip while the other branched south to terminate just in front of the rectangular building first shown on the Second Edition Ordnance Survey map (Fig. 9). This was a slate dressing – or riving – shed and remains extant today. The mill itself is depicted in a semi-ruinous, roofless state with only the outline of some elements remaining visible.

4.41 In 1917, the Langdale Silver Lead and Copper Company took over the site, but the venture was short-lived. A few years later, in 1924, the mine was again re-opened, under the auspices of the Greenburn and Tilberthwaite Mining Company, headed by the mining engineer Oscar Gnosspelius (Adams 1988, 151). Gnosspelius had also purchased the old Coniston mine and working together with his mine manager, John 'Willie' Shaw, hoped to bring both ventures into commercial production. Horse Crag Level was once again cleared and re-timbered, and extended to a depth of 600ft; a ladder-way was cut from this depth to the surface and sealed with a trap door (Cameron 2010, 2).

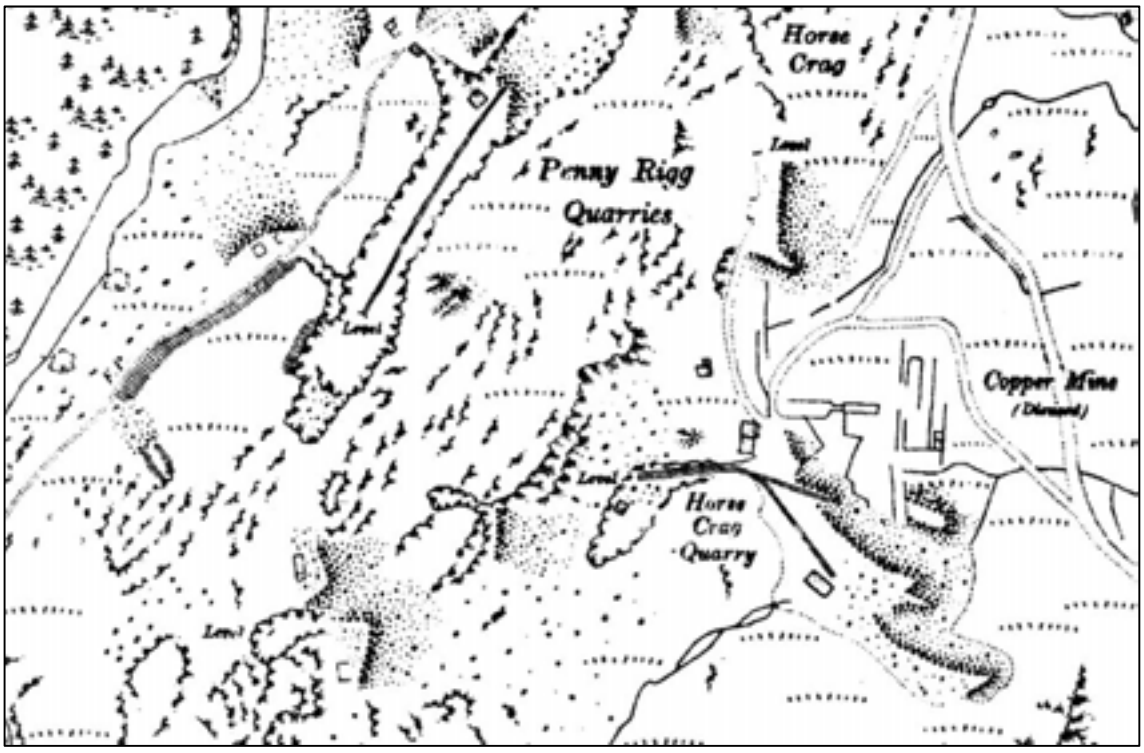
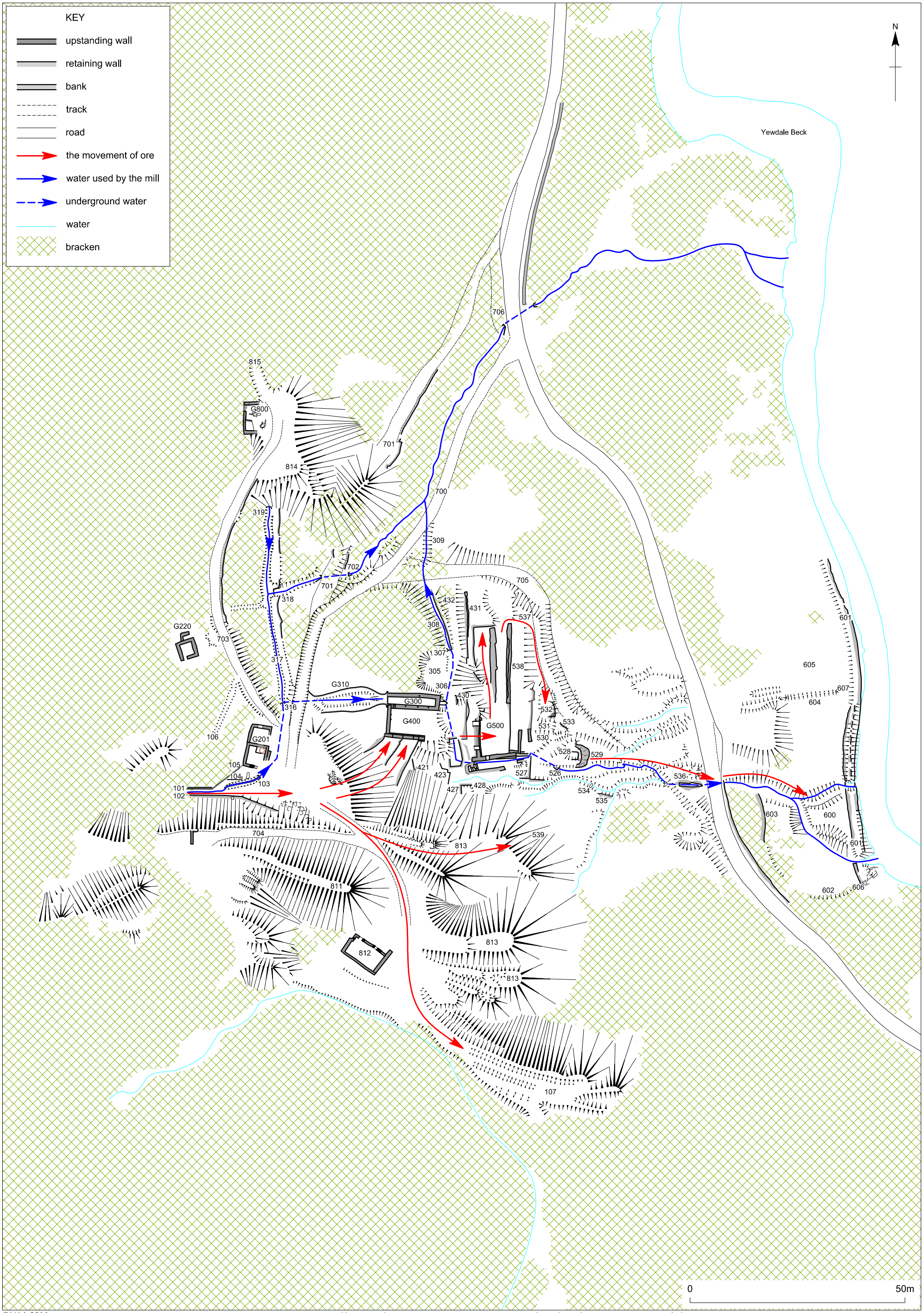


Figure 10: *extract from 25-inch Third Edition Lancashire and Furness Ordnance Survey map, published 1914*

4.42 Despite all of efforts, the output of the mine remained small and the resulting ore was hand dressed and sent by cart to Coniston (Holland 1986). In 1930, another roof collapse blocked the level and terminated production, after which the mine was abandoned once more. Instead, Gnosspelius turned his attentions to working the surface and closehead quarry, installing, amongst other improvements, a paraffin engine air-compressor on an iron wheel chassis to enable the drilling of shot holes. The fittings associated with the compressor can still be seen around the level entrance (Holland 1986).

4.43 The quarry remained in operation until 1938, when Shaw finally retired, and four years later the Greenburn and Tilberthwaite Mining Company went into liquidation. Most



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Penny Rigg copper mill, Cumbria: interpretive topographic landscape survey of the site *Figure 11*

Penny Rigg mill complex, looking west, annotated with key structures and features

Figure 12

recently, George Tarr obtained planning permission to re-open the closehead, working the quarry for 10 years between 1989 and 2000. There has been no activity on site since this date, although the riving shed is still intermittently occupied.

5.0 THE ORE DRESSING PROCESS AND SURVIVING EVIDENCE IN THE LANDSCAPE

5.1 The following section describes and discusses the archaeological evidence surviving at Penny Rigg within the context of the ore dressing process. It looks at how the mill operated, including raising, sorting, crushing and dressing the ore, as well transportation and power transmission across the site. Each feature has been assigned a unique identification number (context number), a full list of which can be found in the site inventory (Appendix 1), illustrated on Figure 11. Building plans and elevations are referred to within the text as appropriate and inserted at the end of the report.

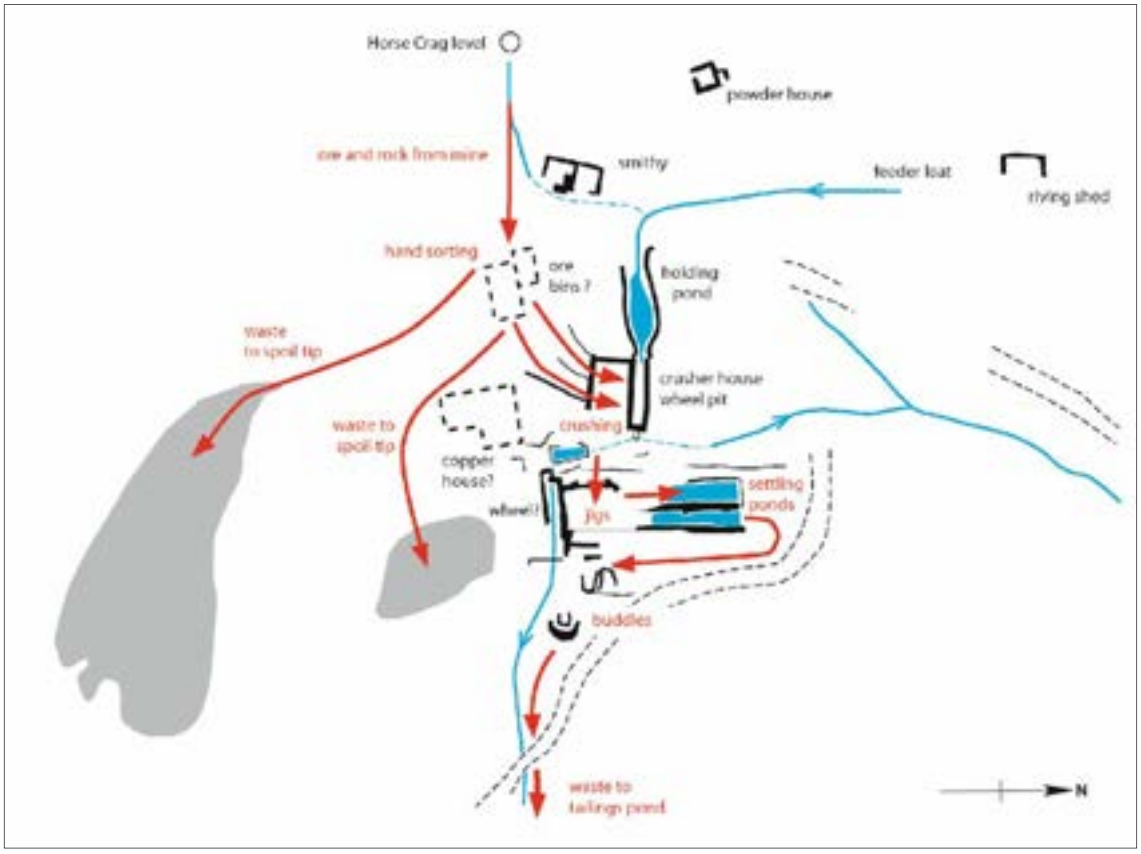


Figure 13: *schematic showing process flow moving downhill across the site. The movement of ore is shown in red and water in blue*

The Penny Rigg dressing mill complex

5.2 The dressing mill complex comprises mechanised crusher (300), (400), dressing mill (500), which would have housed mechanised jigs and possibly stamps, two settling

ponds (520), (521), buddles (528), (530), (531), and various interconnecting leats and channels (Figs 11–13). On the slope to the west of the main complex are two further buildings – the smithy/office (200) and the powder house (220) – both associated with gaining the ore, as well as the level entrance (100).

5.3 All of these elements are arranged to make the best use of the natural topography with the various activity or processing areas situated sequentially down the hillside. This was an ergonomic arrangement in terms of both water flow – used to power the mill and to wash the ores – and transportation, ensuring the heaviest material (deads and untreated ore) entered at the top of the complex and the lightest (the processed ore) remained at the bottom to be transported away.

5.4 To facilitate processing, a series of terraces were cut against the natural slope and their outer faces retained with stone walls (419), (431), (513), (516), (518) (Plates 21, 22). The terraces were used principally as building platforms and some of the retaining walls were incorporated into the structure of individual buildings (for example, the west wall (501) of the dressing mill). In other areas, the natural bedrock had to be quarried to create terraces. This can be seen above the crusher house (adjacent to wall (419)) where shot holes and quarry fractures are plainly visible on a small rocky outcrop.

Building Materials

5.5 All the surviving structures associated with the copper mill are built from local stone. The most common stone is the heavy blue slate extracted from the adjacent quarry, although some lighter, more fissile slate was used in the construction of the second phase structure at the south-east corner of the dressing mill walls (511), (512), (515). Water-rolled cobbles were also used in the second phase sections of the smithy/office (200) and as base courses in retaining walls (527), (529).

5.6 Both the crusher house and dressing mill appear to have had open sides to the east and north and the use of timber for structural supports and cladding must have been widespread. The form and extent of timber use cannot be assessed, but later 19th-century photographs taken at the Coniston mines (Plate 5) show a surprisingly large number of wooden and wooden-fronted buildings, and it is likely that timber was also used extensively at Penny Rigg mill.

Phasing

5.7 The exact date when the dressing mill complex was completed is uncertain, but it was probably between 1867 and 1868; it is depicted as operational on the Lampton map dated *c.* 1869. Following the 1875 sale, Wynne does not appear to have continued work at Tilberthwaite, or at least ceased production at the mine relatively soon after purchase. As early as 1883, Horse Crag Level is reported as being in a poor condition in Hellen's survey, although this does not refer to the mill directly. The first phase of operation at the mill was, therefore, very short, perhaps less than 10 years, representing a very poor return on the sum invested in its construction.

5.8 There is some evidence of modifications, which suggest there was a second phase of use, probably during the ownership of James Fleming between 1889 and 1891. Evidence for this is observed in the crusher house, smithy, dressing mill and modifications to the track layout.

5.9 The dressing mill complex had closed by 1892, when Thomas Warsop re-opened Penny Rigg quarry, and was dismantled and sold for scrap soon after.

Plate 5: *a late 19th-century view of the Bonsor Lower Mill at Coniston copper mines showing the extensive use of timber in the mill buildings. In the foreground is a set of unenclosed water powered jigs and to the left are open settling ponds. Taken from Holland 1986, 174*

Stage 1: Mining the copper – driving the level

> *When copper pyrites occurs coarsely intermixed with quartz and other earthy minerals, the dressing usually begins with hand-picking and crushing by rolls; the coarser grains are jigged, and the finest particles are cleaned and rendered rich enough for sale, by buddles, frames, revolving tables, or endless belts. Intermediate products made up of ore and waste have to be re-crushed before a complete separation is possible.*
>
> *Le Neve Foster, C. (1894)* Text-Book of Ore and Stone Mining

5.10 Penny Rigg mill was built to process copper ore from Horse Crag Level (101). The level, which measured 1,039yd (950m) long, was designed primarily to drain the mine and provide access to deeper, and potentially richer, sections of the copper vein. It was driven using gunpowder – black powder – for blasting, the more stable dynamite not being used at Coniston until 1877 (Holland 1986, 162). The notebook of materials received (AML AMATL 2016.881) makes frequent references to the ordering of barrels of gunpowder between 1865 (when the book begins) and 1868, with an estimated 2,890 pounds of powder being delivered monthly to the mines, at a cost of 6d a pound (Holland 1986, 161).

5.11 Mechanised drilling was still in infancy at this stage, compressed-air rock drills not being introduced until the 1880s, and much of the tunnel would have been blasted using hand-driven shot holes. Two miners were required to drill, one holding and turning the drill – or jumper- while the other beat it with an iron hammer. The resulting shot holes were filled with gunpowder and fired using a straw fuse. Broken rock was thereafter loaded by hand into a wagon or tub and taken out along the level to be dumped. The spoil tips at the south end of the site, with the distinctive orange-brown colour (107) are composed primarily of waste material produced during the driving of the level once it reached the vein. Given the length of the level, and size of the tubs still *in situ* underground (W. Allison pers. comm.), horses would have been used to do the hauling, but no stables have been identified at the site.

Level portal and entrance (101), (102) (Figs 11–13)

5.12 The level portal (101) and associated entrance cutting (102) survive in good condition and still provide access to the underground workings (NZ 30590, 00693) (Plates 6, 7). Both have been reused on a number of occasions for slate extraction – most recently in the 1990s (Cameron 1996, 152) – and although the level portal appears to retain its

original rectangular form it is likely that the entrance cutting has been altered. This is most apparent on the south side, directly in front of the entrance where the lower workings of the quarry have resulted in the removal of the cutting wall, which has been partly backfilled with slate spoil.

Plates 6, 7: *(left) portal to Horse Crag Level (101) and (right) associated cutting (102), note water continues to drain out of the adit*

Plate 8: *interior of Horse Crag Level, photograph (c) W. Allison*

5.13 The copper ore at Tilberthwaite was carried in vertical fissures – or veins – mixed with

quartz and broken rock. The miners worked the vein using picks and gunpowder and as much waste rock as possible was dumped underground, often left as packing in worked-out chambers or stopes. All the other rock, including ore bearing 'veinstuff', was trammed out to the surface along the level.

5.14 Barratt and Taylor had first introduced steel drilling chisels to Coniston from the Devon and Cornish mines where they were used extensively. Steel was more durable than the more traditional iron jumpers, which needed to be frequently repaired and sharpened by the mine smithy. However, it took a number of years to establish the widespread use of steel and initially the smiths simply welded steel tips to the old iron tools.

The Smithy (201) (Figs 14–17)

5.15 The Penny Rigg smithy (201) is one of two surviving buildings on site directly related to the working of the mine, the other being the powder house (220). The main function of the smithy was to prepare and sharpen the miners' drills – a daily task – and to undertake running repairs on the mine tubs and other general mining equipment. The location of the smithy, immediately east of the entrance cutting (101) (NZ 30607, 00714), emphasises its association with underground work.

Plate 9: *east-facing elevation of smithy back wall (205) showing the levelling of the wall at intervals with smaller flat pieces of slate*

5.16 The surviving two-celled structure comprises the smithy to the south, closest to the mine level (101), and an office to the north. Based on the structural evidence, it is clear that the smithy was built first and the office was added later. The west back wall (213) of the office butts up against the back wall (205) of the smithy. The date of the expansion is unknown, but must have been before 1869, the two-celled structure appearing in its completed form on the 1869 Lampton map (Fig. 8).

5.17 The whole structure is built into the slope of the hillside, the walls constructed of random-coursed rubble, containing a mixture of slate and water-rolled cobbles. The slate and the cobbles vary in size, but the former was used to level the courses. This can clearly be seen within wall (205), where at roughly half-metre intervals the random rubble courses are levelled by using smaller, flatter pieces of slate.

***Plate 10**: internal north elevation of wall (202), showing blocked door (203) to the left*

5.18 The building features evidence of both its original use (209), (210), (211) and modification over time (203), (204). The south wall of smithy (202) survives to a maximum height of 1.40m internally, towards the rear of the building. The height of the wall decreases towards the front. This wall includes evidence for what is believed to be a

blocked doorway (203). The blocked door is *c.* 0.90m wide and the blocking survives to roughly five courses high. There is an obvious straight joint between the blocking (203) and the wall (202). The blocking consists of rough rectangular blocks.

5.19 It is assumed that alternative access into the smithy was created through the east wall (207), although due to the ruinous condition of the wall there is no current evidence for this. Accessing the smithy from the front, rather than the side of the building may have been easier due to the presence of a large, relatively flat open area. Accessing the smithy from the south end of the building would have been made difficult by the presence of the leat channelling water draining from Horse Crag Level and culvert (103), and by sloping ground.

5.20 The west (rear) wall of the building (205) is built into the hillside, serving as a retaining wall (Plate 9). It survives to *c.* 2.30m in height internally and 1m externally. The north wall (206) of the smithy, which also forms the dividing wall between the smithy and the office, has been badly damaged in places by a tree growing through the structure. Wall (206) survives to a maximum height of 1.90m internally, towards the back of the building, and deceases in height towards the front. The upper half of the wall consists of coursed random rubble and the lower half contains more even-sized rectangular blocks of slate. Where walls (206) and (207) meet they survive to roughly three courses, which contain some very large slab-like pieces of slate, used to form simple quoins.

Plates 11, 12: *(left) east-facing elevation of the buttress (208), (right) north-facing elevation of the buttress (208)*

5.21 The east (front) wall (207) of the smithy is in a very ruinous condition. It survives to a maximum height of 1.60m either side of which it tails off towards the ground and the surrounding rubble. Its maximum length is no more than 3.00m. The wall is visibly leaning outwards, which may have been a problem even before it became ruinous, and could explain the presence of buttress (208). The wall may have needed more support because of the location of the internal hearth (209).

5.22 The buttress (208) is built predominantly of coursed large, flat rectangular stones. Both sides taper to the top. The inside tapers to accommodate the outward lean of wall (207). Approximately every other course consists of through-stones and it survives to a maximum height of 1.30m at its north end. The north face survives intact. It is not possible to tell exactly how far the buttress ran across the front of the building due to its ruinous condition at the south end; it survives to a maximum length of 2.10m.

5.23 The hearth (209) currently has a large tree growing out of its centre, which has caused considerable damage, making it difficult to see the original form of the feature (Plate 13). The hearth is built into the north-east corner of the smithy, and measures *c.* 2.10m by 1.40m, surviving to a maximum height of 1.00m. The western elevation is roughly keyed into the north wall (206) and is made up of random-coursed, roughly rectangular blocks. The bellows hole and metal inlet pipe (210), (211) survive at its west end. The bellows hole (210) is a roughly square opening measuring 0.30m by 0.30m at its widest points (Plate 14). The aperture is approximately 0.15m deep. The metal inlet pipe (211) is 0.15m in diameter and made from iron. The pipe extends into the hearth for a distance of *c.* 0.60m, at which point it meets the trunk of the tree.

***Plates 13, 14**: (left) hearth (209), facing north, (right) west-facing elevation of hearth (209) showing bellows hole (210) and metal inlet pipe (211)*

5.24 In the south-west corner of the smithy is a valve (204), which is connected to a compressed air pipe (105) (Plate 15). The iron compressor pipe, 64mm (2½in) in diameter is attached by iron brackets to the north wall of Horse Crag Level and the north side of the entrance cutting. It runs north-east along the surface from the east end of the cutting towards the south-west corner of the smithy. The presence of the valve (204) (Plate 16) and the compressor pipe (105) demonstrate the changing use of the building and the changing methods for working the mine.

***Plates 15,16**: (left) compressed air pipe (105), (right) compressed air pipe valve (204) in the smithy*

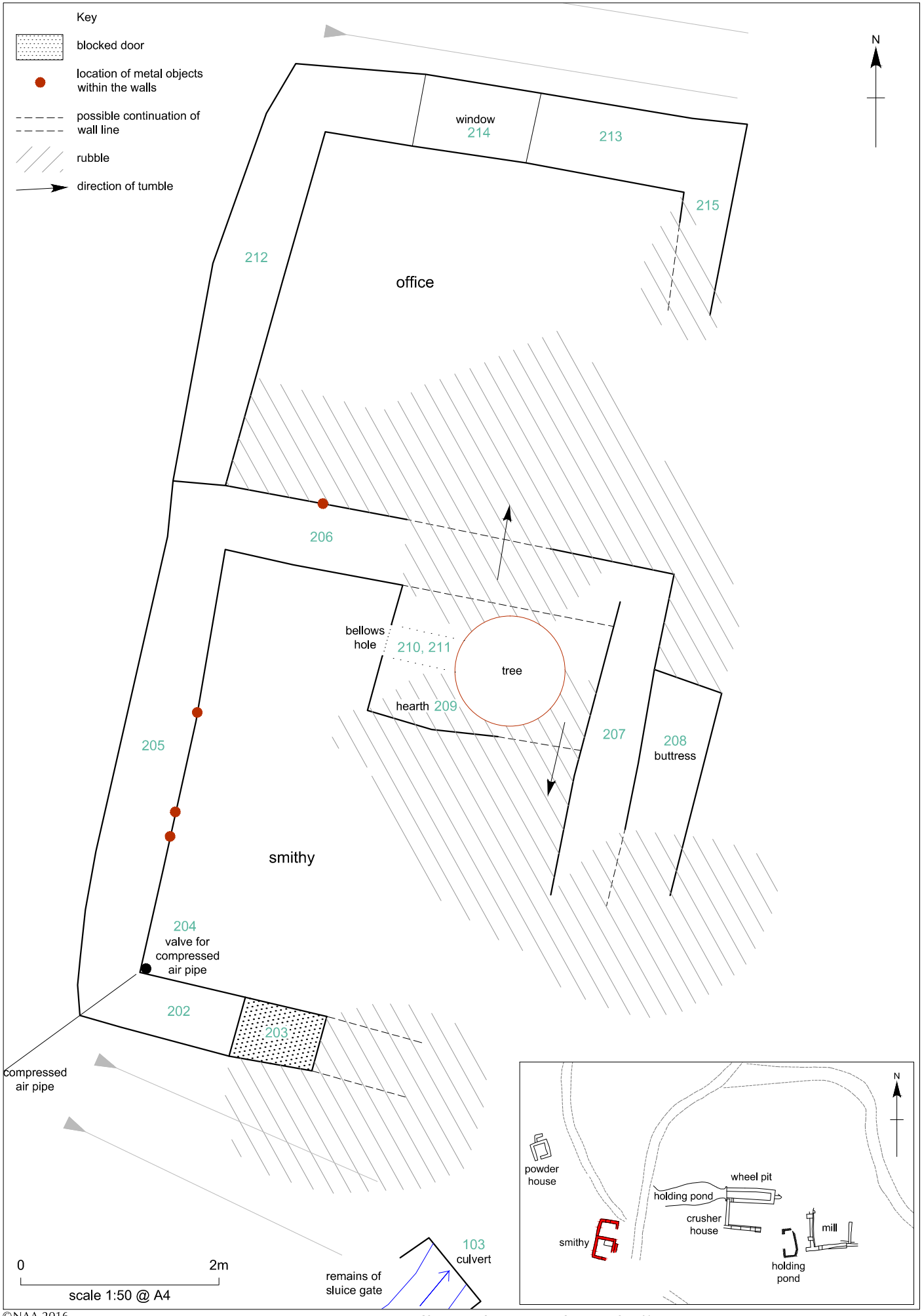
5.25 The rear wall of the office (212) butts up against the rear wall of the smithy (205) forming a straight joint, which suggests it was built after the smithy. However, although not *exactly* the same, the construction of the two buildings is very similar. The construction of the rear wall of the office is noticeably different from the rear wall of the smithy (205). Wall (212) also acts as a retaining wall, built into the hillside. It survives to roughly 1.80m high internally and 0.45m at its highest point externally.

5.26 Wall (213) forms the gable end, or north wall of the office, either end of which has roughly dressed quoins. The west end tapers towards what would have been the apex of the roof. This helps to confirm that the building would have been a single storey. The wall survives to *c.* 2.60m at its highest point internally and 1.80m at its highest point externally. There is a single offset window opening (214), which is approximately 0.90m wide. The stones forming the windowsill are keyed into the wall. The window is 1.80m above the ground internally and *c.* 1.00m above the ground externally. At the top of the current opening on the west, there is a large square block of stone where the top of the window may have been; this may have supported a roof beam.

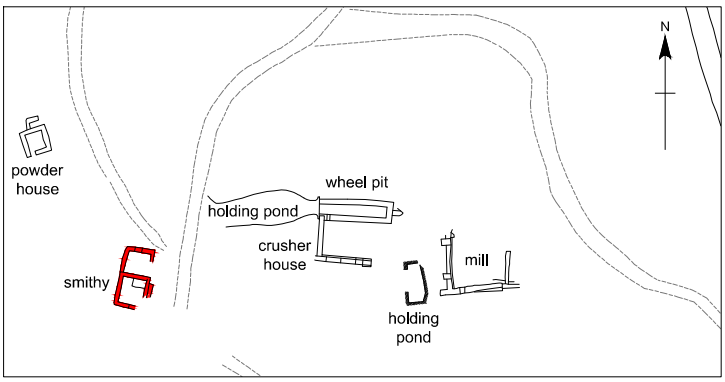
Plate 17: *remains of the smithy (201), looking east*

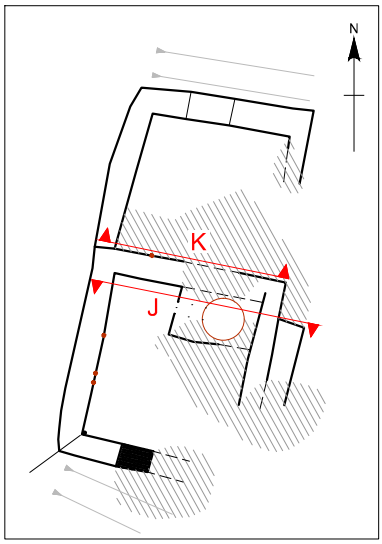
Plate 18: *north-facing gable wall of smithy (201), looking south*

5.27 Very little of the east wall (215) of the office survives; where it does, it is *c.* 1.20m high at its highest point and 2.00m long. Roughly dressed quoins at the north end of the wall are noticeably larger at the base. Currently, there is no clear evidence for where the door



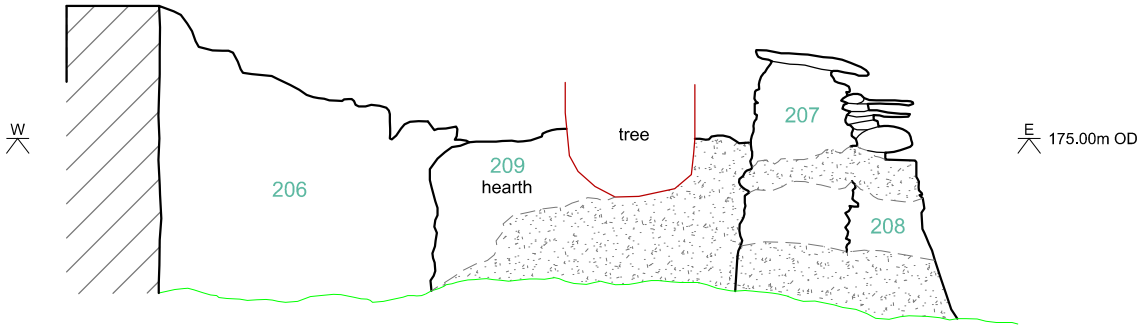
Penny Rigg copper mill, Cumbria: smithy and office *Figure 14*



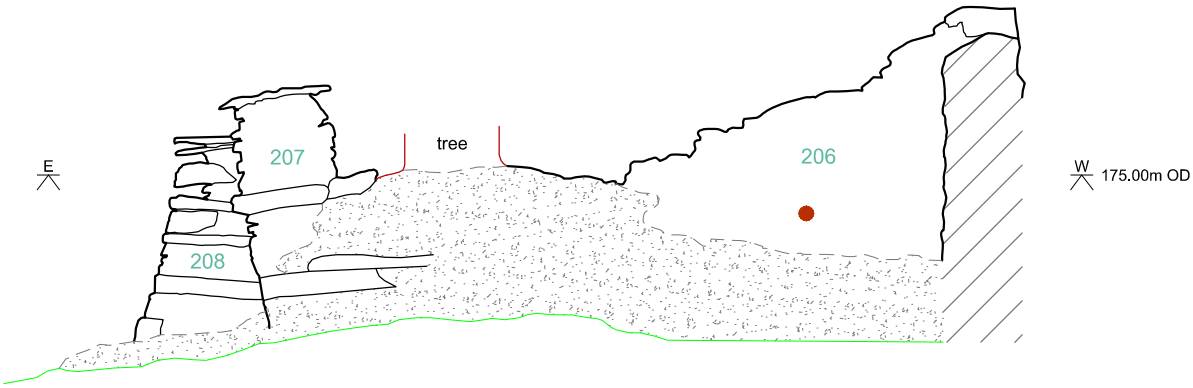


Smithy and office - cross wall elevations

J South facing elevation



K North facing elevation



Key

location of metal objects

rubble

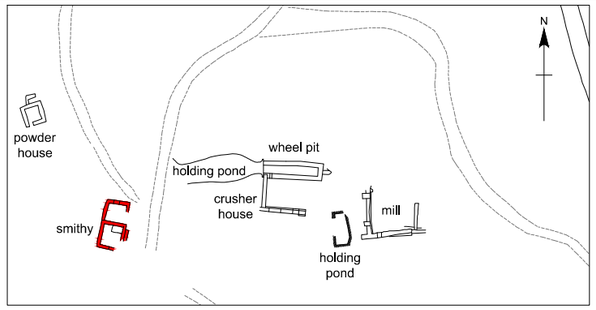
wall

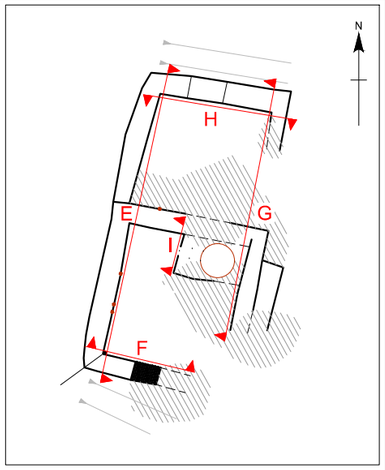
0 2m

scale 1:50 @ A4

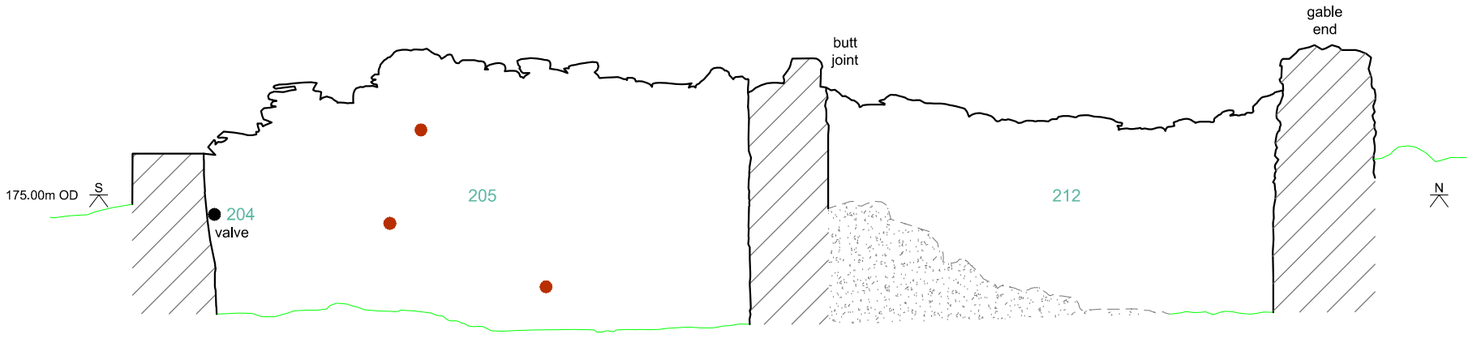
Penny Rigg copper mill, Cumbria: smithy and office cross wall elevations *Figure 15*

Smithy and office - interior elevations

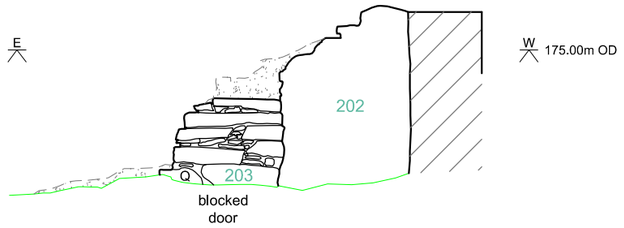




E East facing elevation

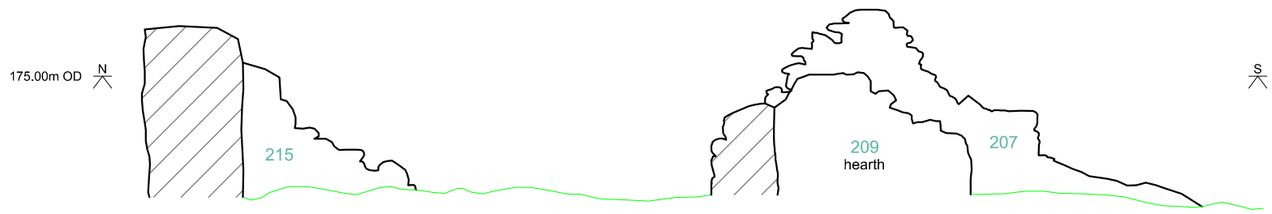


F North facing elevation

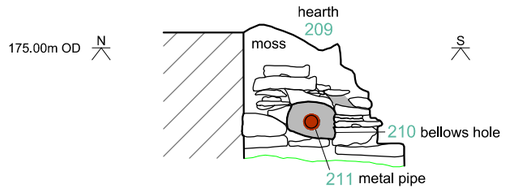


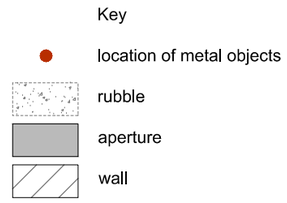
H South facing elevation

G West facing elevation



I West facing elevation





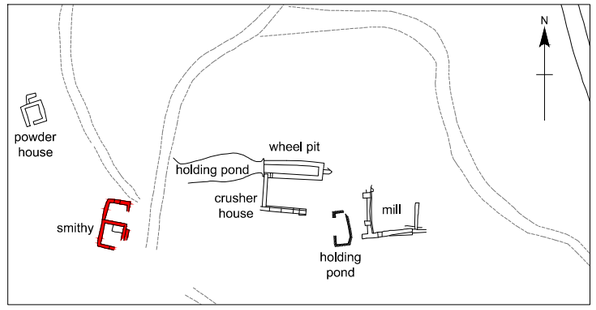
0 2m

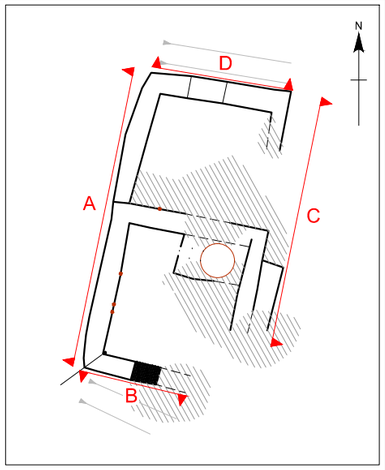
scale 1:50 @ A3

Penny Rigg copper mill, Cumbria: smithy and office interior elevations

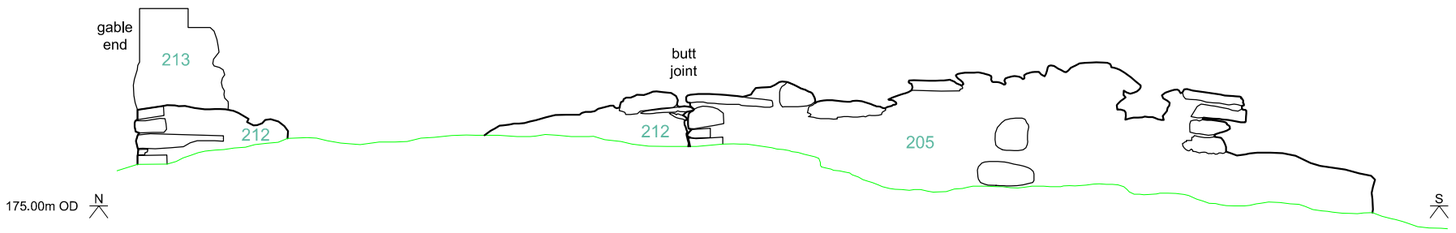
Figure 16

Smithy and office - exterior elevations

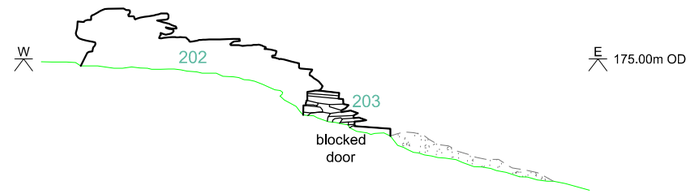




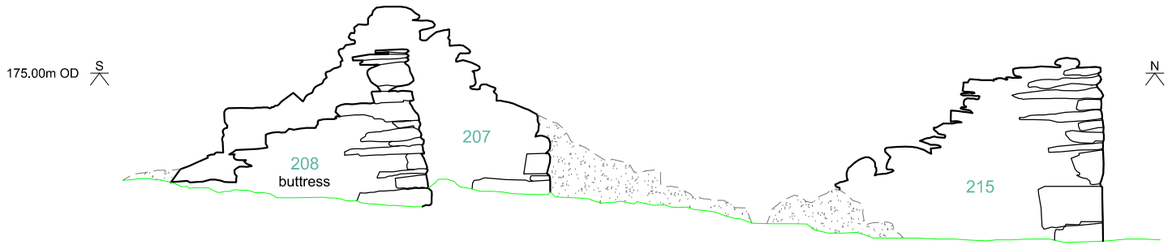
A West facing elevation



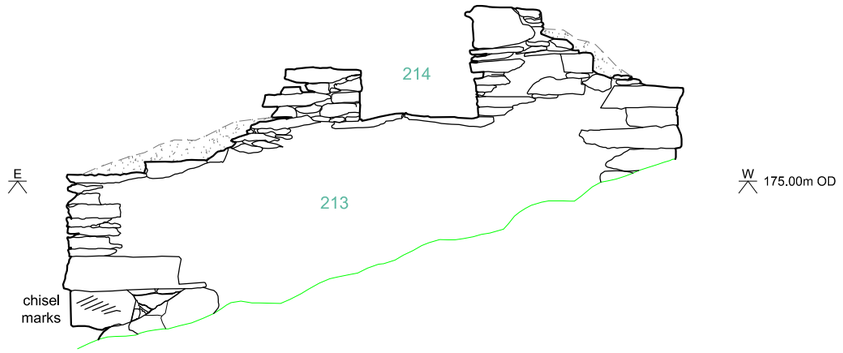
B South facing elevation



C East facing elevation



D North facing elevation



0 2m

scale 1:50 @ A3

Key

rubble

Penny Rigg copper mill, Cumbria: smithy and office exterior elevations

Figure 17

may have been and it does not appear that the wall was keyed into the front wall of the smithy, especially as the north-east corner of the smithy (206), (207) has roughly dressed quoins.

Powder house (220) (Figs 18–20)

5.28 The second surviving building relating to the driving of the level and extraction of the ore is the powder house (220). This is located on the hillside north-west of the smithy, set back from track (703) (NZ 30591, 00736). The building is shown on the Lampton map *c.* 1869, marked 'Powder House' and would have been used for storing the mine's gunpowder. By the mid-19th century, there was growing concern about the use and supply of explosives in the extraction industries and the Metalliferous Mines Act of 1872 prohibited the storage underground of explosives, and required all mines to be equipped with a suitable magazine above ground. The Penny Rigg powder house is not shown on the 1850 Ordnance Survey map (Fig. 5), although blasting had presumably already begun by this time on Horse Crag Level.

5.29 The powder house building is quite simple in design, comprising a square, single-storey, one-cell structure with a door opening (222) facing south and no windows (Plate 19). It is built partially into the hillside, with an attached small annex (228), (229) to the north. Unlike some other powder houses, such as that at Roseberry Topping ironstone mine (NAA 2013), there is nothing to suggest the construction of sod-cast blast banks, but being built into the hillside would have help absorb some of the impact from an accidental explosion. The building was also set at some distance from both the mine and the mill.

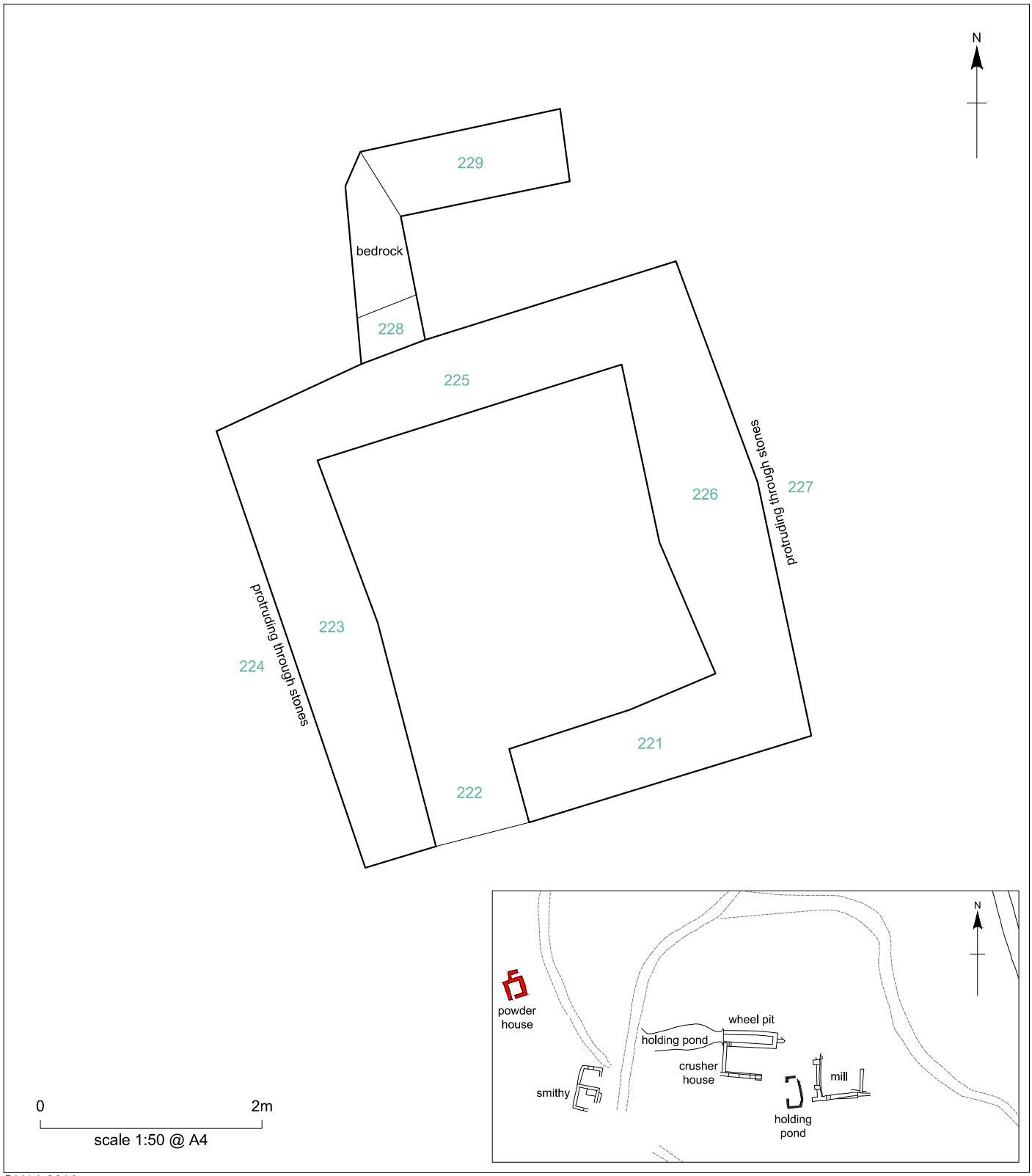
5.30 It is built of coursed random slate rubble, with roughly dressed quoins. Many of the quoins are made out of large slabs that have been used end-on to make them look like large blocks of stone from the front. This is particularly noticeable in the east wall (226). Both gable walls (223), (226) survive to full height and have strategically placed protruding through-stones (224), (227) at three evenly spaced levels. The stones are flat to the wall on the internal elevations, but protrude on the outside.

5.31 The south wall (221) mostly survives to full height. The construction method is similar to that observed in the west (rear) wall (205) of the smithy. At roughly half-metre intervals the random rubble courses have been levelled by using smaller flatter pieces of slate. The west end of the wall contains a door opening (222). There are two gaps in the wall to the

west (223) of the door, which may indicate where the door was originally hung. The north wall (225) also mostly survives to full height.

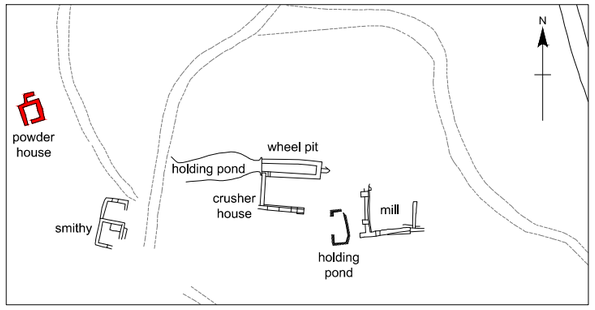
Plates 19, 20, 21: *(above) powder house (220) south-facing elevation and door opening (222), (below left) east-facing gable end and (below right) interior*

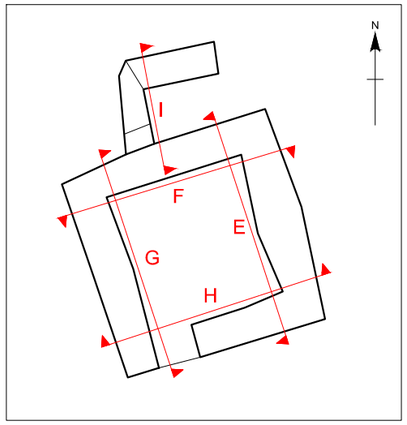
5.32 The location of the small annex to the north appears to have been determined by the presence of bedrock. The west wall (228) was created by filling the gap between the exposed bedrock and the north wall (225) with coursed random rubble. The wall survives to a height of 1.30m. The north wall (229) of the annex was constructed from



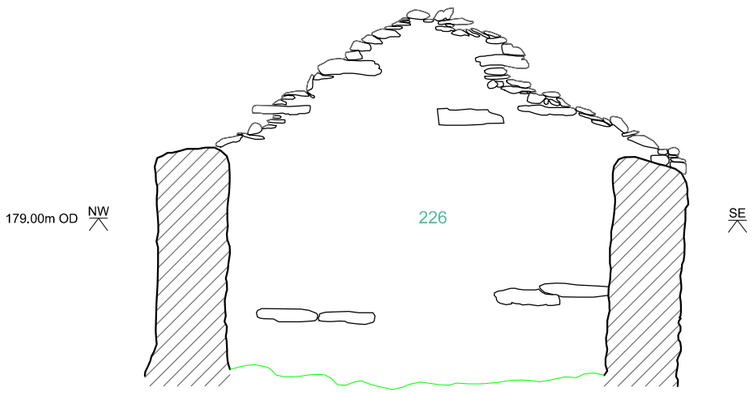
Penny Rigg copper mill, Cumbria: powder house plan *Figure 18*

Powder house - interior elevations

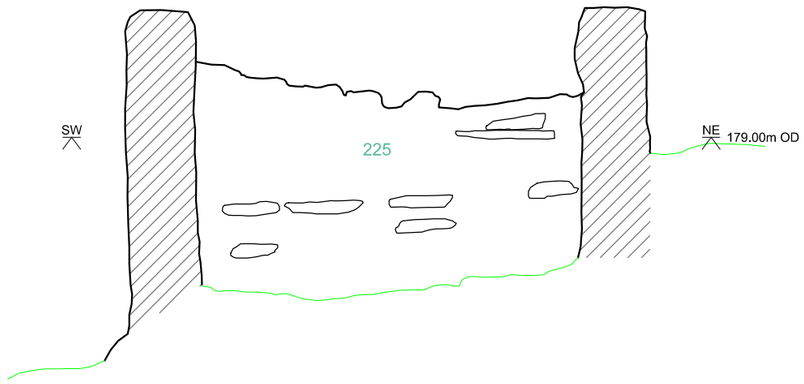




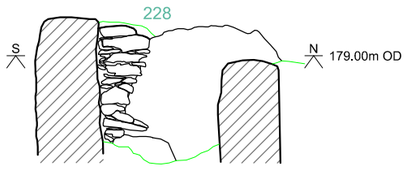
E South West facing elevation



F South East facing elevation

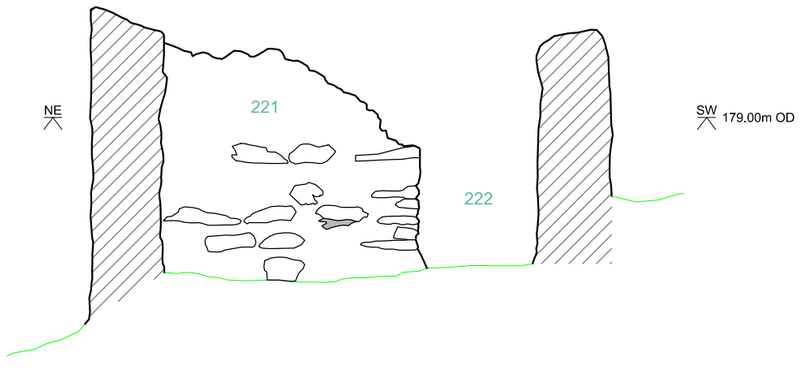


I North East facing elevation



G North East facing elevation

H North West facing elevation



0 2m

scale 1:50 @ A3

Key

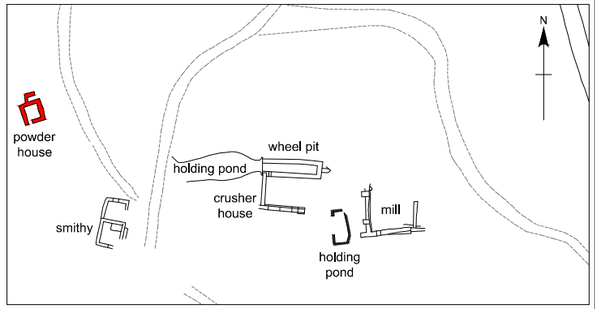
aperture

wall

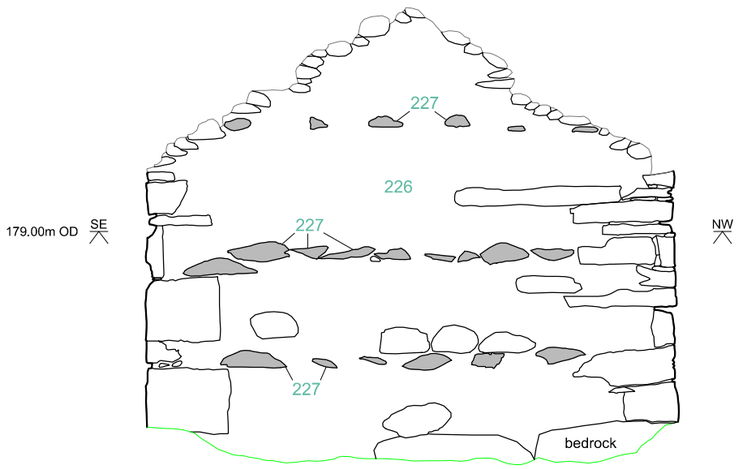
Penny Rigg copper mill: powder house interior elevations

Figure 19

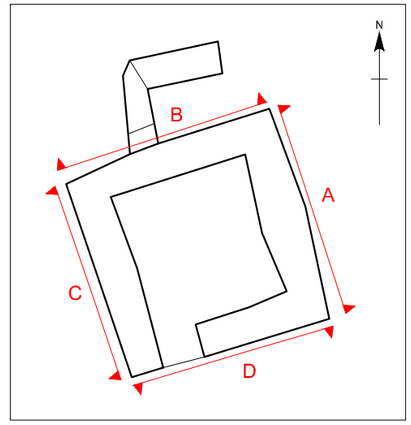
Powder house - exterior elevations



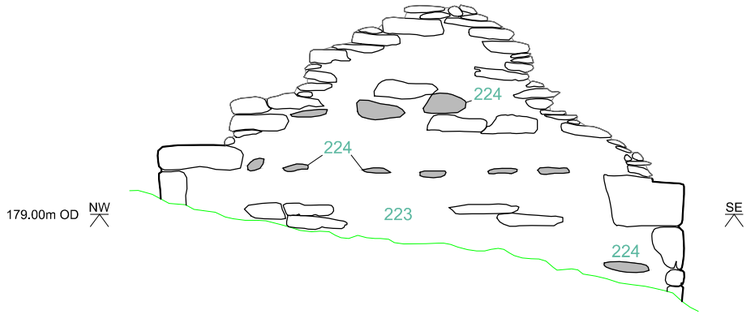
A North East facing elevation



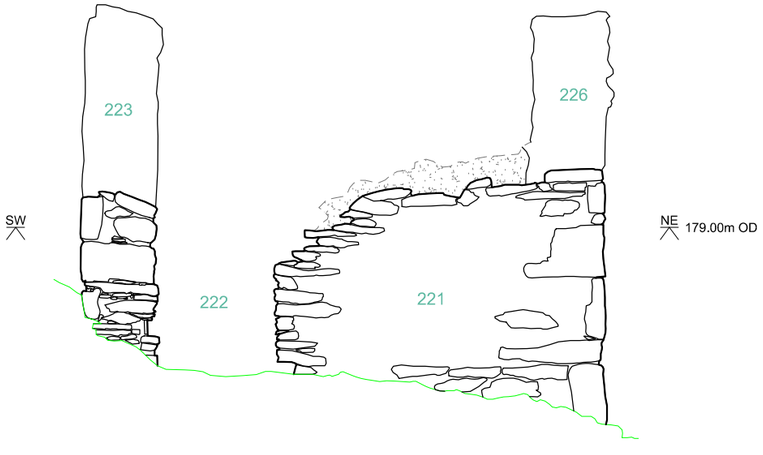
B North West facing elevation

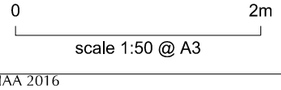


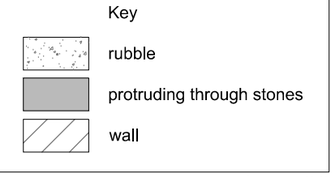
C South West facing elevation



D South East facing elevation







Penny Rigg, copper mill, Cumbria: powder house exterior elevations

Figure 20

coursed random rubble built up against the exposed bedrock. It survives to 1.00m high and 1.70m long.

Area in front of the mine cutting

5.33 The broad terrace to the east (front) of the entrance cutting to the mine is the product of later slate quarrying, in particular the working of the closehead quarry in the early 20th century. A number of features associated with the mine and copper mill must have been buried by the quarry working and resultant rid tips. Other than the buildings described above, the only other surviving original feature in this area is spoil tip 107. This has the distinctive orange-brown colour of the mineralised rock and the remains of parallel tip lines at its south-east end (Plate 22). The north section of the tip lies under slate spoil tip (813) and its original extent is unknown.

Plate 22: *the distinctive orange-brown mineralised rock of spoil tip 107, associated with the working of the mine and partially buried beneath the later slate rid tip (813)*

Stage 2: Sorting the ore from the waste rock

5.34 All the material brought out of the mine went through a series of operations designed to separate waste stone (deads) and mineral (gangue) from the copper ore; this process is called ore dressing. At most mines the crude ore from the mine was tipped directly into

an open-fronted stone hopper or 'team' with an iron grate at the base; the grate allowed the crude ore to be sorted by size. Crude ore from the grate was cleaned with water and hand-picked to remove any waste rock before the remaining material was broken or 'ragged' to a uniform size using sledge hammers. It was then hand-picked again to remove any further waste. Ragging was generally done by men or older boys, but before the introduction of crushing rollers it was common practise for women and girls to break the ore to a smaller size by hand, a process known as cobbling and bucking. Because Penny Rigg copper mill incorporated mechanised crushers from the outset, it is unlikely that the complex ever included bucking sheds.

Plates 23, 24: *(left) short section of retaining wall (419), covered by later rid tip at its south end; this may be associated with the mill sorting area and culvert beneath track (420) (right), potentially carrying waste from the ore cleaning operations*

5.35 All the waste from the initial picking and ragging was dumped and may have formed part of tip (107), although it is probable that much, if not all, of the lower tip (539) is also composed of hand-picking waste. If this interpretation is correct, the waste must have been transported to the tip along an inclined track that is now buried beneath slate waste (813). In fact, later slate waste (813) has buried or destroyed nearly all the evidence for ore sorting at Penny Rigg. One might anticipate finding at least one or more ore hoppers or bins close to the mine entrance for sorting, as well as a building for storing sorted ore. The Lampton map shows two buildings, now lost, in the area east of the smithy and on line with the Horse Crag Level portal (Fig. 8). One or both of these structures could be ore hoppers, especially as they appear to have been located at the south-west end of the two tracks (414), (416) leading to the crusher house. A short length of retaining wall (419) associated with an area of broken ore may be a surviving part of the ore sorting area, but much of this feature is also buried beneath slate waste.

5.36 There is no surviving evidence for the use of water for cleaning the crude ore, but water draining from the mine level could have been diverted for this purpose. Culvert (420) (beneath track (414) to the crusher house) appears to have drained the area upslope to the west and may have carried waste water from ore cleaning operations (Plate 24).

Stage 3: Crushing the ore

5.37 The first stage of the dressing process was to crush the sorted and ragged ore. Crushing rollers were first used in British mining in the early years of the 19th century. They are recorded in use at Wheal Crowndale copper mine in Devon in 1808, a mine managed by John Taylor from 1798 to 1830[5]. Taylor took over Coniston mines and Tilberthwaite in 1824 and, together with John Barratt, was probably responsible for the introduction of crushing roller technology to the local area.

5.38 Barratt's Penny Rigg mill was designed from the outset to employ crushing rollers. These were powered by a waterwheel, described in the 1875 sales notice as a large waterwheel measuring 32ft (9.75m) in diameter. The wheel was housed in a rectangular wheel pit (300) with the axle supported on massive horizontal timbers set on the east-west wall heads. Water was supplied to the west end of the wheel from a raised holding pond (310) via a wooden launder, probably controlled by a sluice gate.

The leat (317), holding pond (310) and wheel pit (300) (Figs 21–25)

5.39 The leat, holding pond and wheel pit all survive in relatively good condition. The feeder leat (317) for the crusher house waterwheel, or at least that part within the survey area, measures 48m long and for most of its length has a stone-faced retaining bank on the east side (Plate 26). At the north end of the leat, a stone-sided and slab-capped culvert (319) carries the water beneath rid tip (814). The majority of (814) comprises material from driving quarry level (815), constructed to carry water from Penny Rigg slate quarry to the copper mill.

5.40 Approximately 17m south of culvert (319) is an overflow channel (318) cut into the east bank of the leat. This contains the remains of a timber box-drain and some wooden uprights, probably associated with a sluice gate (Plate 25). The overflow was used to control the flow of water to the holding pond and waterwheel with any surplus diverted in a channel down the hillside to Yewdale Beck. At the south end, the leat –

[5] Citing online reference 'Industrial Archaeology of the Tamar Valley' at http://www.tvia.org.uk/pages/mining_lodes21_27.shtml, accessed 12/10/16

supplemented by water draining from Horse Level through culvert (103/316) – would have fed directly into the holding pond (310), but any archaeological evidence for this has been destroyed by the construction of mine track (700).

Plates 25, 26: *(left) box-drain in leat (318) and (right) south wall of the holding pond (313); note collapse of east wall just visible on the left side of photo*

Plates 27, 28: *(left) remains of the Penny Rigg wheel pit, with bolts for the horizontal wheel supports still* in situ*, and (right) turfed-over remains of the holding pond (310)*

5.41 The holding pond (310) survives intact except for the east end of wall (312) where some of the facing stone at the top has collapsed. Constructed against the natural slope, the oval, raised pond is supported by two massive retaining walls (311), (313) (Plate 26) with expanded sides. The pond itself is now drained and turf-covered, but originally was probably clay-capped (Plate 28). Two small rectangular holes in the face of the north wall (311) are either putlog holes for scaffolding or weep holes to allow the interior of the structure to drain. One curious feature is a change of building style at the west end of the south side wall where the regular rubble construction of wall (313) is replaced by a

cruder, boulder-founded wall (314). The relative phasing of these two features is unclear, but wall (314) may represent a later rebuilding or extension to the holding pond structure, possibly by Fleming in 1890-91. A sluice gate is likely to have been positioned at the east end of the pond, controlling water flow, via a timber launder, onto the waterwheel; no archaeological evidence for this survives.

5.42 The end wall (312) of the holding pond was constructed directly above, and partly covers the west end of wheel pit (300). The pit is a substantial rectangular structure, orientated east to west and measuring 11.20m by 1.70m internally. Like the holding pond and the adjacent crusher house, the walls are well-constructed of random-coursed slate rubble, but also include some exceptionally large – boulder-sized – stone blocks. The wall head, where intact, is capped with large rectangular stone slabs, and the south side retains a full set of four wrought iron holding bolts (320), placed vertically within the fabric of the wall (Plate 29). These were used to secure a horizontal brace (no longer *in situ*) running the full length of walls (301) and (302), supporting the waterwheel axle. Rectangular voids on the internal faces of walls (301) and (302) provide access to the base of the holding bolts.

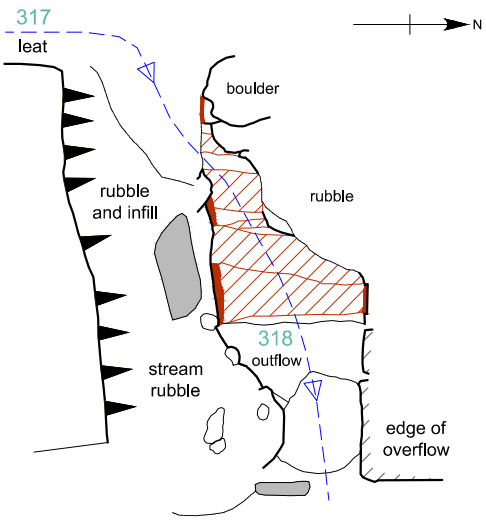

Plates 29, 30: *(left) detail of one of the holding bolts at the top of the wheel pit (320) and (right) vent of race at the base of wheel pit (303)*

5.43 On the north side of the wheel pit is a level, rectangular area (305), measuring 4.60m by 9.60m, slightly terraced into the natural slope. This may be the remains of a working platform or might mark the footprint of a timber structure; it is possibly significant that within the space is a small spread of crushed mineral.

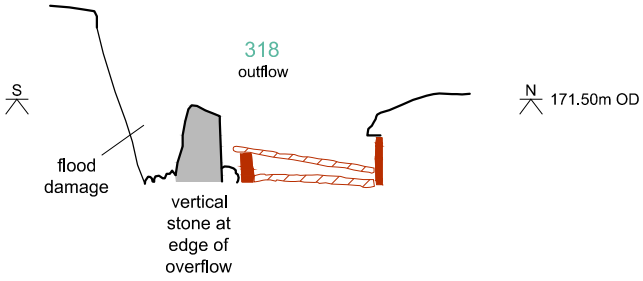
5.44 Outflow water from the wheel exited from a vent at the base of the east wall of the wheel

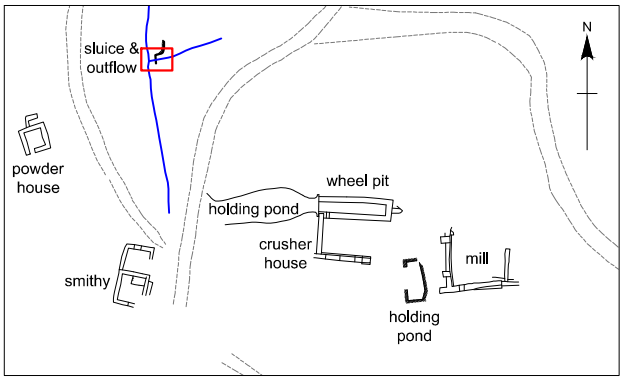
Outflow with remains of timber box culvert

Plan of sluice and outflow



East facing section of sluice and outflow





Key

Vertical stone

Wood

Vertical wood

Walling of uncertain thickness

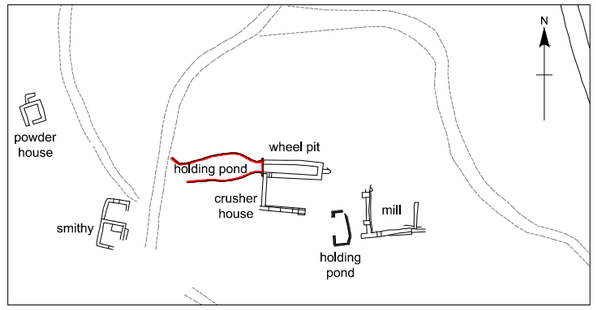
0 2m

scale 1:50 @ A4

Penny Rigg copper mill, Cumbria: sluice and outflow plan and elevation *Figure 21*

700
track

slate waste



311

315 linear channel

312

314
change in walling style

313

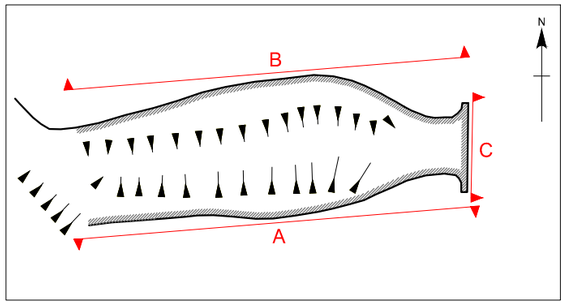
Key
rubble
wall

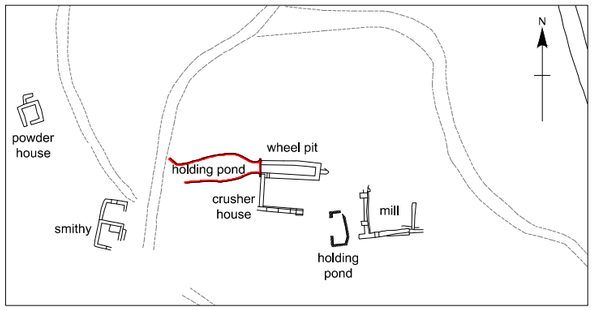
0 2m
scale 1:50 @ A3

Penny Rigg copper mill, Cumbria: holding pond plan

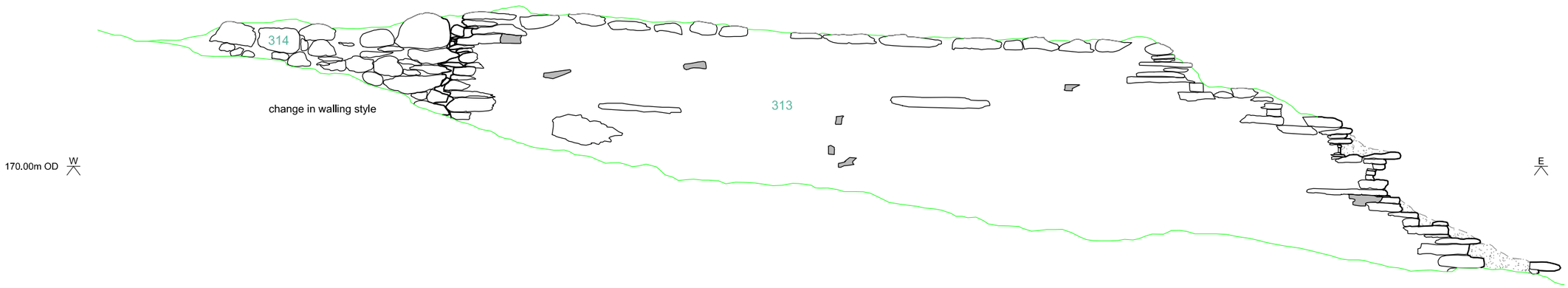
Figure 22

Holding pond elevations

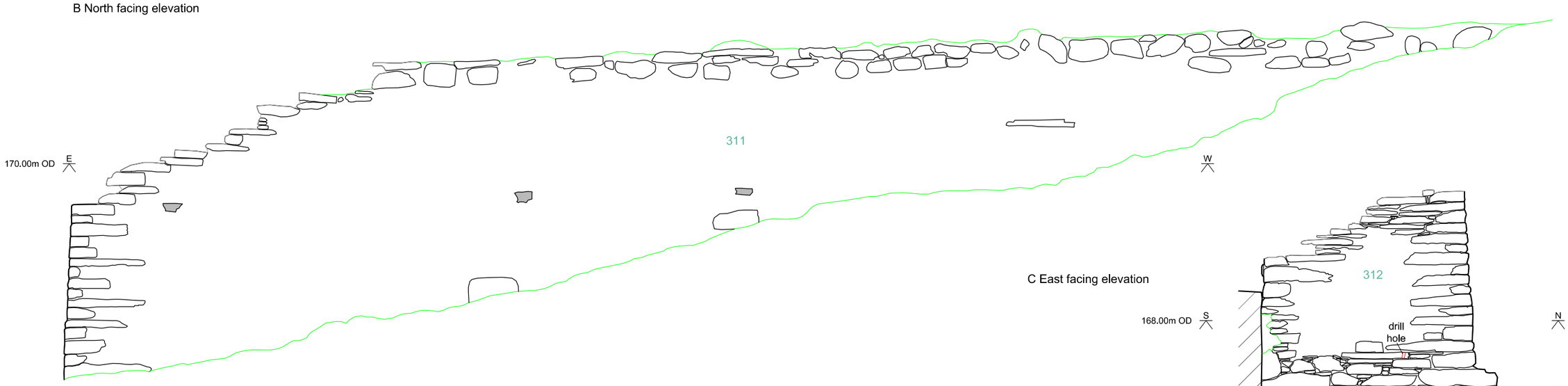




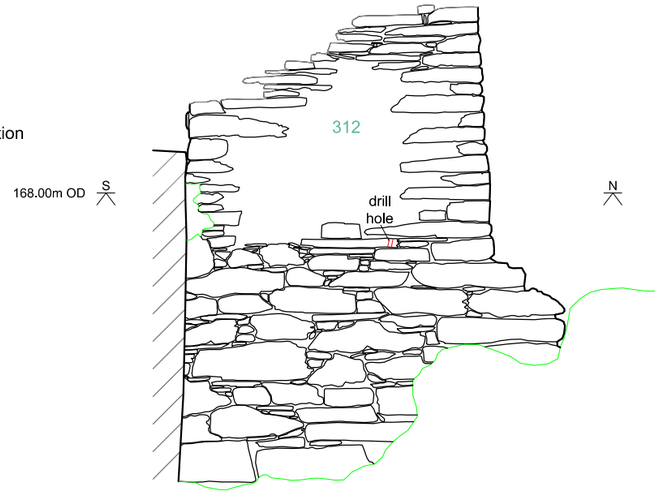
A South facing elevation



B North facing elevation



C East facing elevation



Key

rubble

aperture

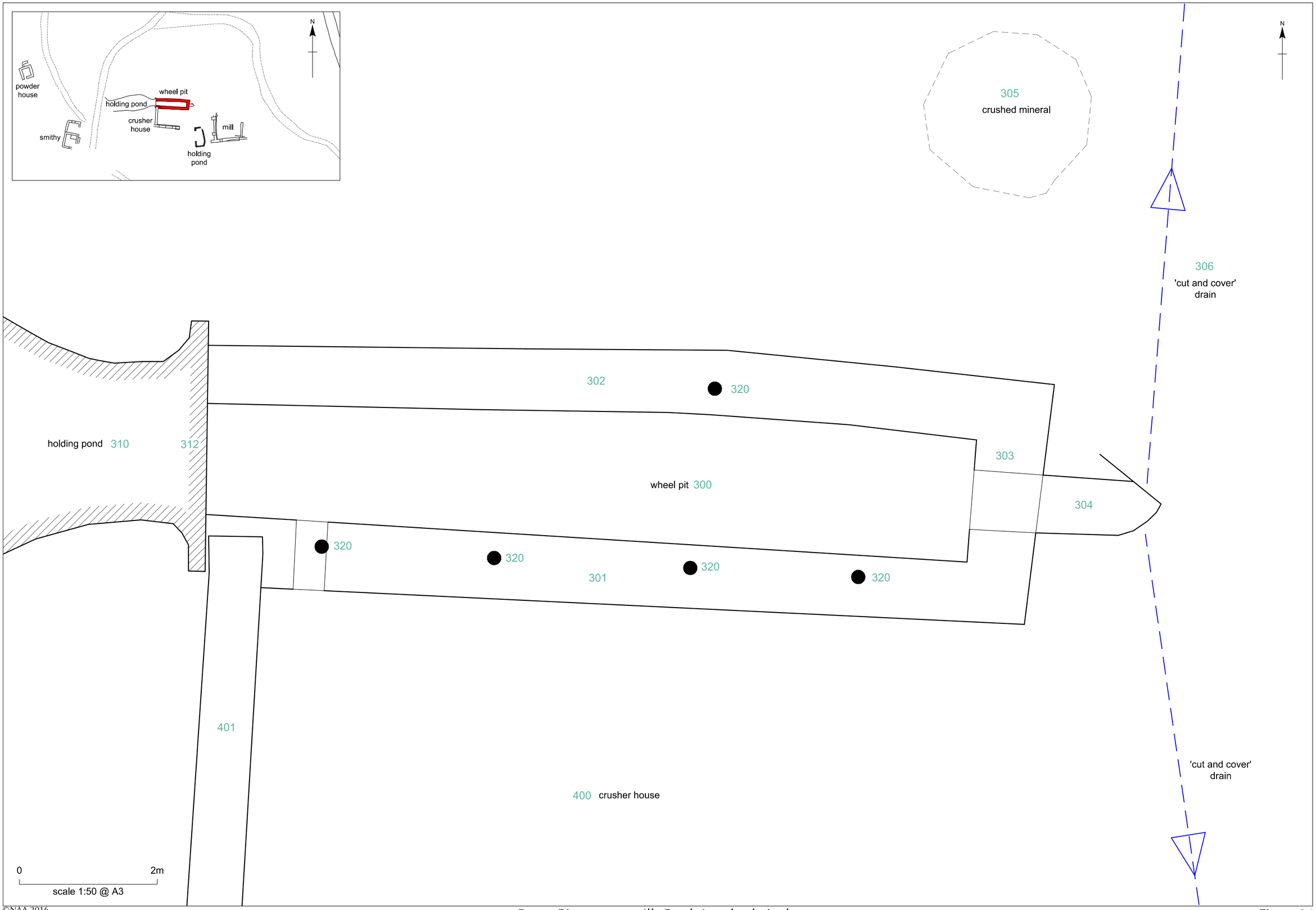
wall

0 2m

scale 1:50 @ A3

Penny Rigg copper mill, Cumbria: holding pond elevations

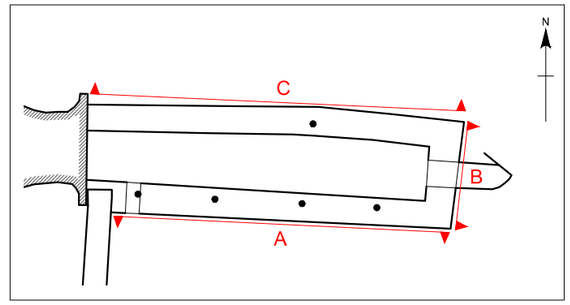
Figure 23



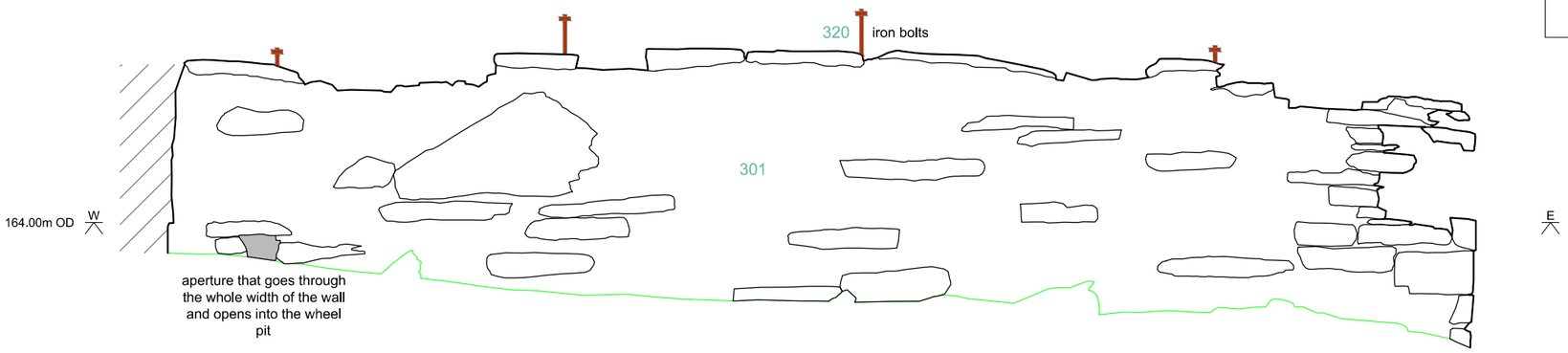
Penny Rigg copper mill, Cumbria: wheel pit plan

Figure 24

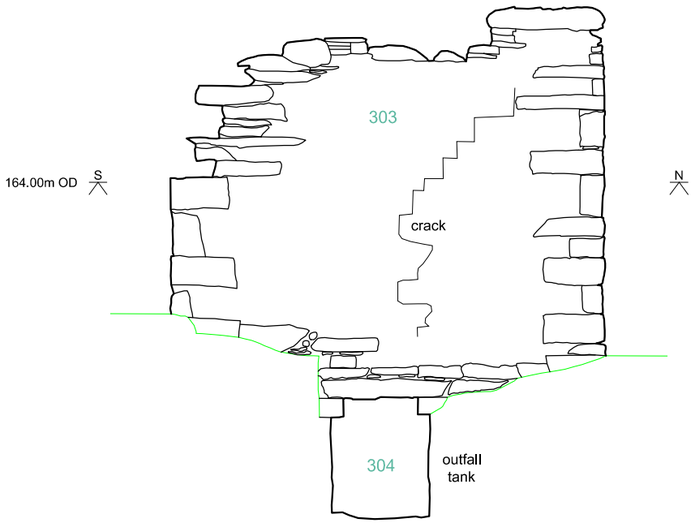
Wheel pit - exterior elevations



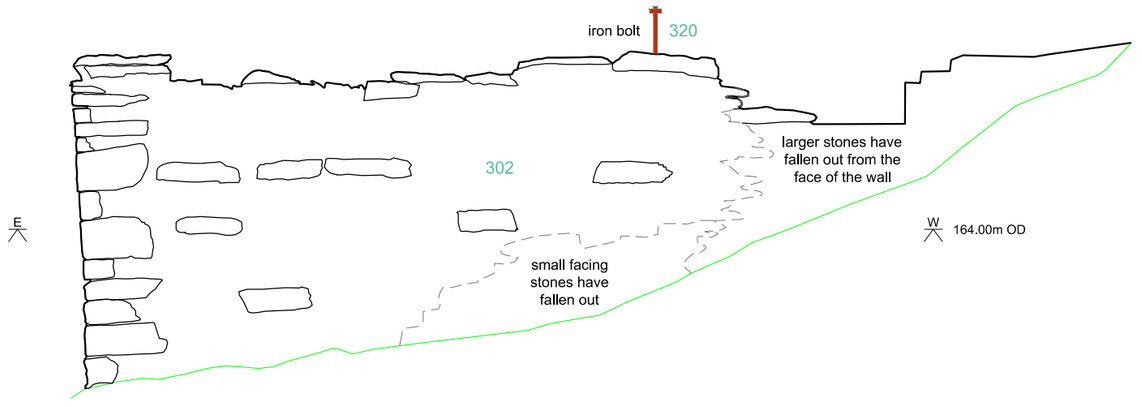
A South facing elevation

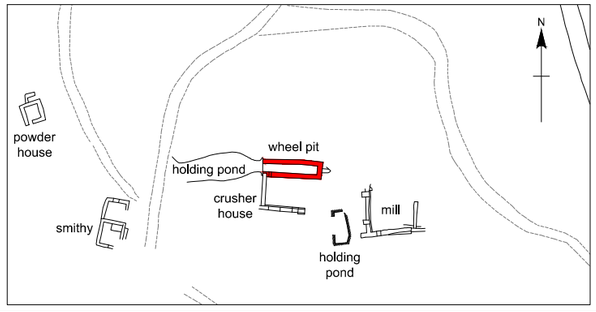


B East facing elevation



C North facing elevation





Key

aperture

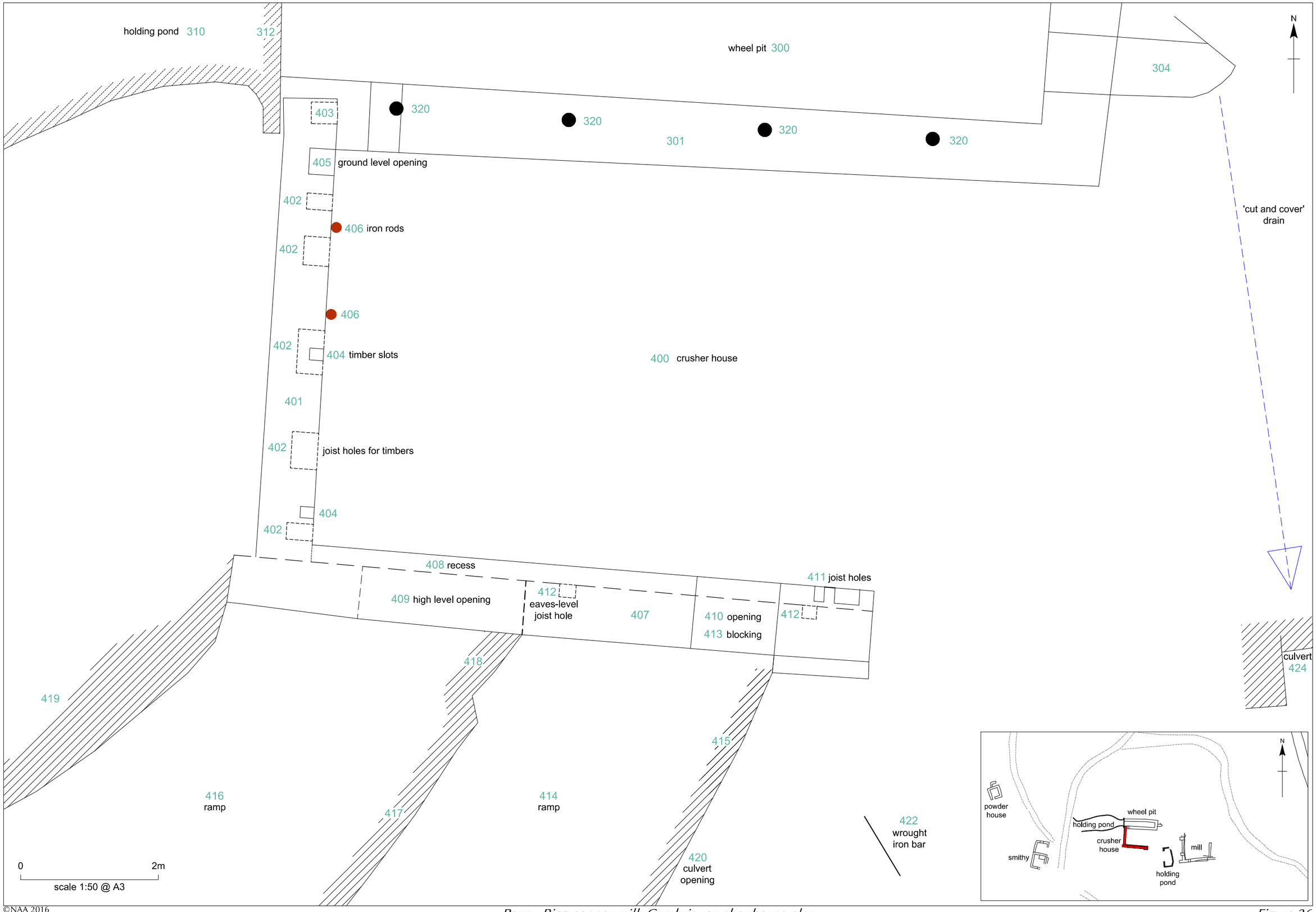
wall

0 2m

scale 1:50 @ A3

Penny Rigg copper mill, Cumbria: wheel pit exterior elevations

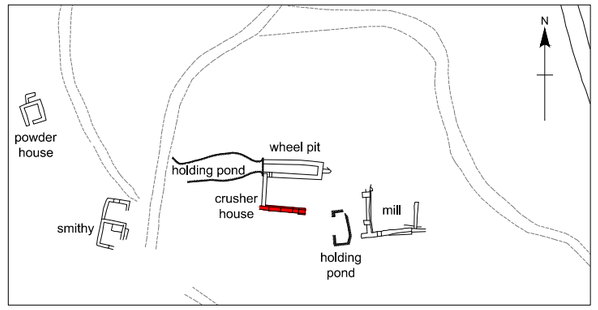
Figure 25

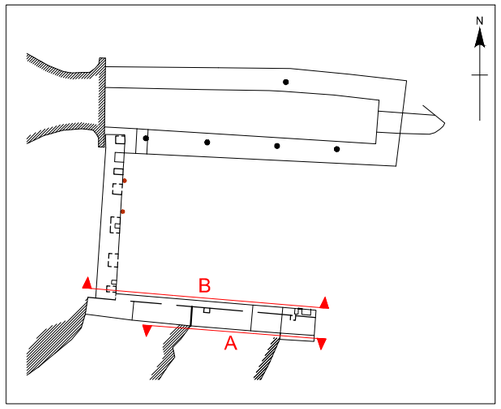


Penny Rigg copper mill, Cumbria: crusher house plan

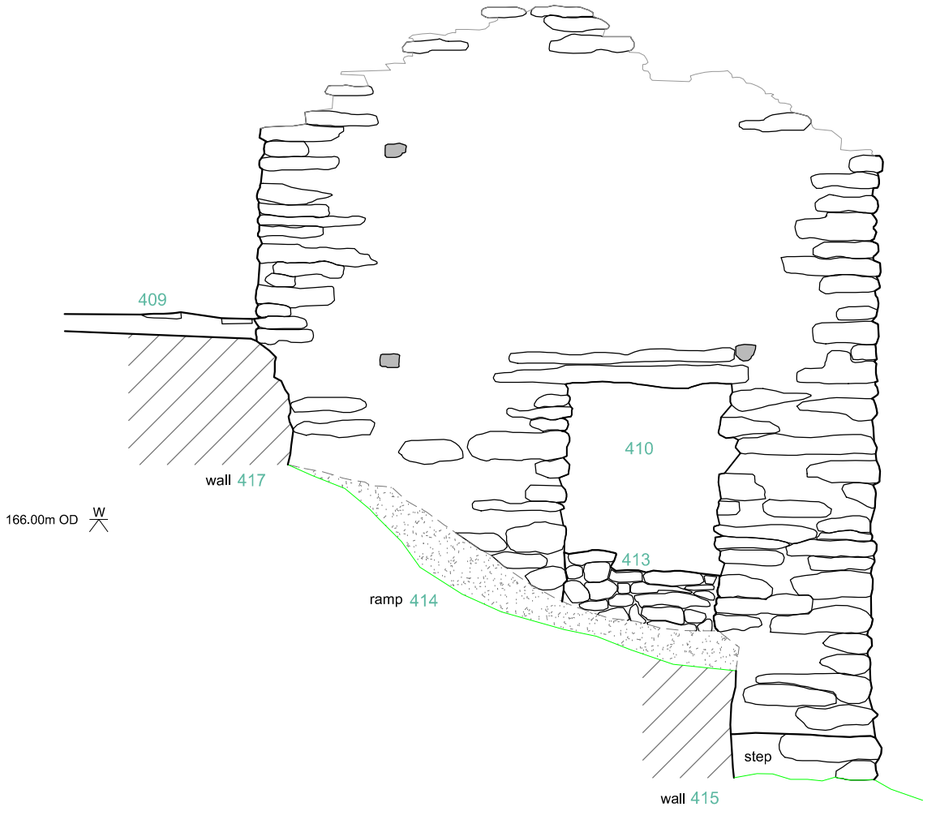
Figure 26

Crusher house - south wall elevations

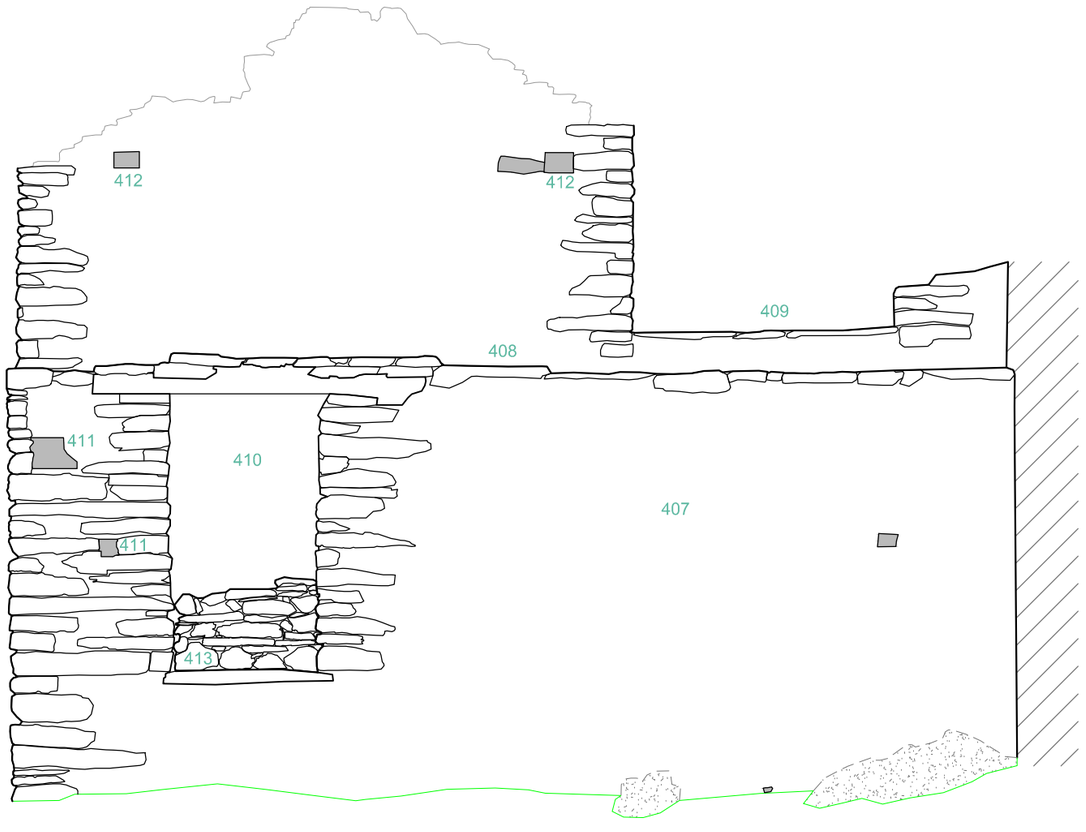


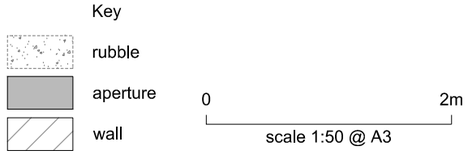


A South facing elevation



B North facing elevation



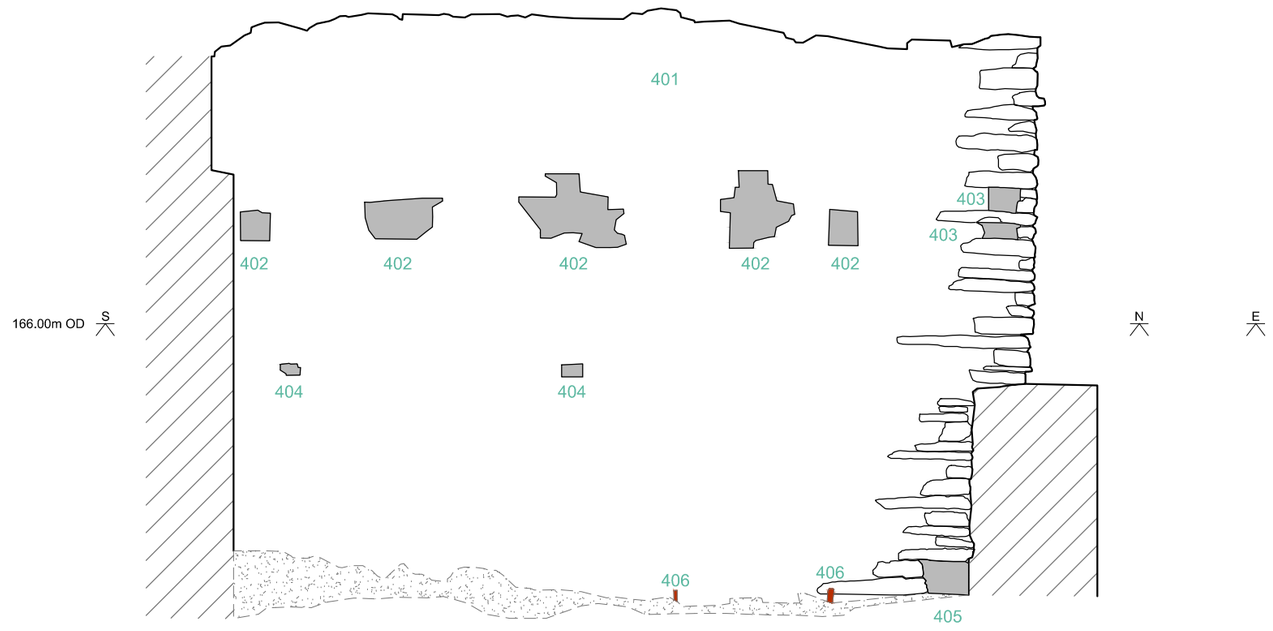


Penny Rigg copper mill, Cumbria: crusher house elevations

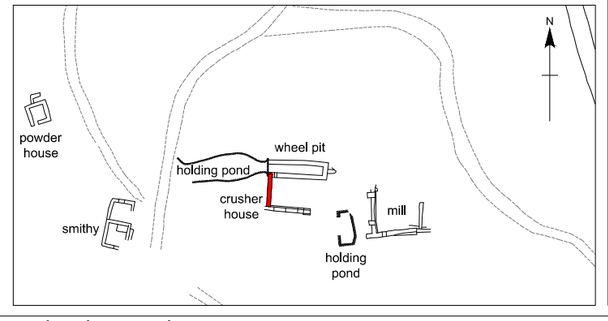
Figure 27

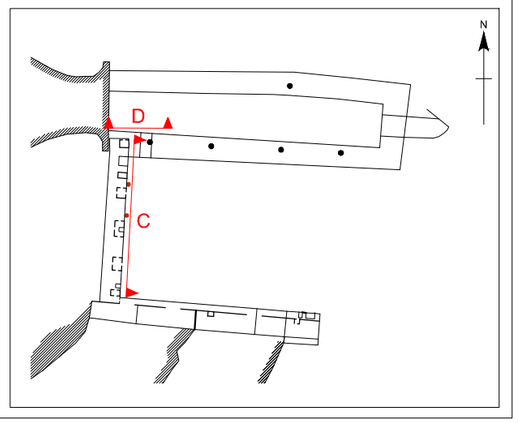
Crusher house - west wall elevations

C East facing elevation



D North facing elevation





Key

rubble

aperture

wall

0 2m

scale 1:50 @ A3

Penny Rigg copper mill, Cumbria: crusher house elevations

Figure 28

pit (303) into a rectangular tank (304) (Fig. 26; Plate 30). Surplus water was channelled north through a stone-slabbed culvert (306) to an open leat with an up-cast bank to the east; the inner face of the leat is stone-walled. At the north end, this has been backfilled by the construction of track (705), but continues further north as leat (309). This has been cut by track (700), but would have originally continued north to the watercourse below the feeder leat's outflow sluice (318). Outflow water from the wheel race was channelled, presumably via a sluice gate, into culvert (424) to be used elsewhere in the mill complex.

The crushing house (400) (Figs 26–28)

5.45 Most water-powered ore crushers comprised two cast iron rollers. One roller was set on an extension of the waterwheel's axle and both rollers were geared to turn inwards against each other. Crude ore was fed into the rollers from a hopper and the crushed material was collected in a revolving sieve – known as a trommel – which sorted the ore by size (Figs 29–31). Crushed ore of the correct size – generally gravel size – fell through the holes in the trommel and was collected for further processing. Larger material passed through and was returned to the crusher on a 'raff-wheel', a fixed wheel with elevator buckets on its side that was also powered by the waterwheel.

> After passing under the scrutiny of the pickers at the sorting table, the next process is to reduce it (the ore) to a size suitable for jigging. The almost universal practice in Cornwall and Wales, existing up to the present day, was to effect this crushing by means of a pair of crushing rolls, as shown in (the illustration). The fixed roll was coupled direct on to the axle of the waterwheel, while the other or movable roll was free to slide in the bearings as shown, being pressed up against the fixed roll by means of the long weighted lever. Below is seen a small screen or trommel. The coarse ore rejected by this falls into the " raff" or elevating wheel as shown, and is lifted up again and fed back into the rollers. The general dimensions of this type of crushing rolls are as follows : Pressing levers, vertical arms, 11 ¼ inches ; horizontal arms, 144 in., loaded at end with weights, giving a pressure of 1100 lb. per inch of width for crushing the ore; average size of rolls, 24 in. x 15 in. ; speed, from 4 to 8 revolutions per minute ; capacity, 2g tons per hour to 3 mesh. The diameter of the waterwheel varies from 25 to 50 ft. I know of many of these wheels still at work, and the older style of mining 'Captain' vigorously maintains that they are better than any other mill going.
>
> Davies, E.H. (1902) *Machinery for Metalliferrous Mines*

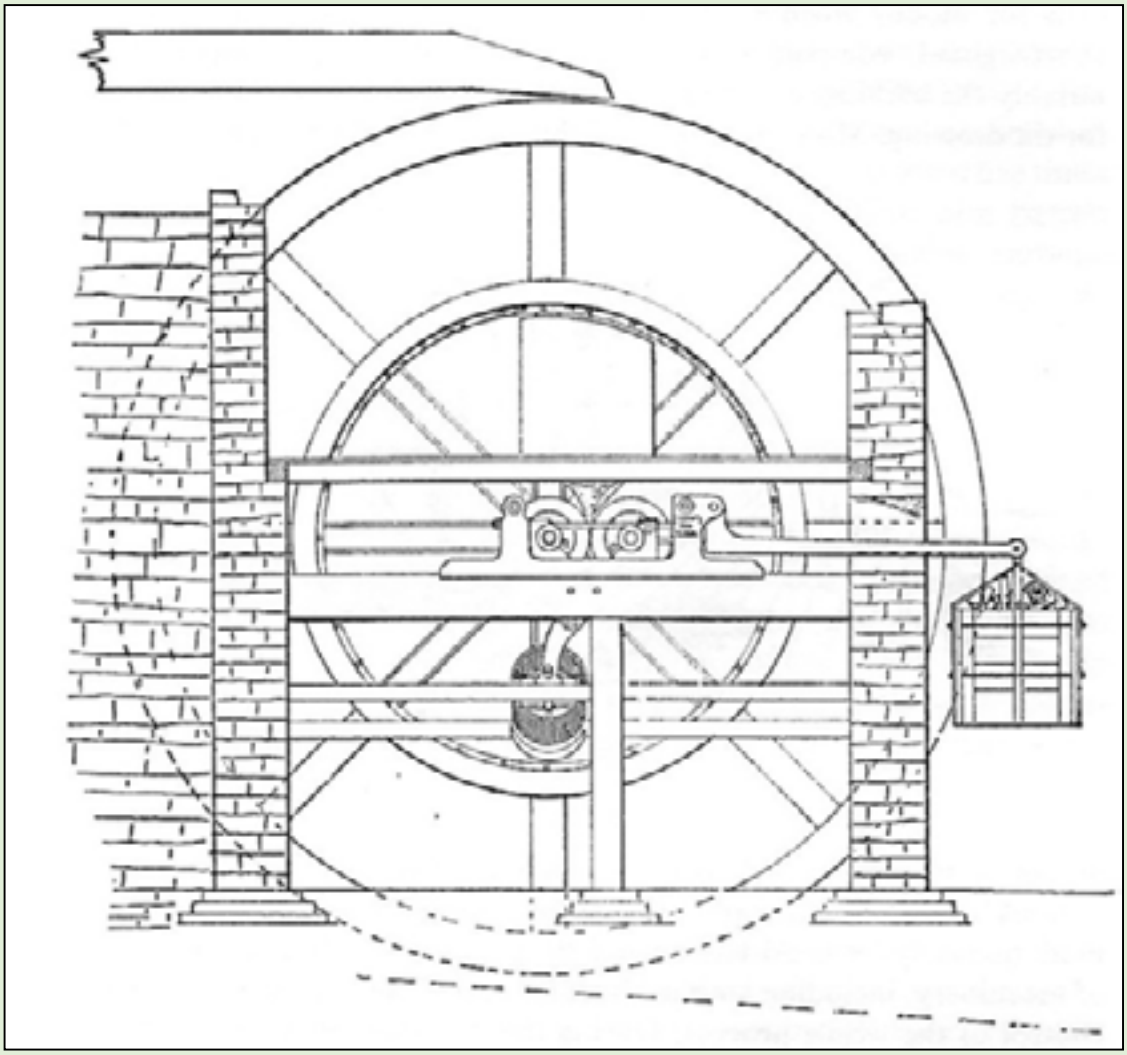


Figure 29: *Section of a water-powered dressing mill from Davies 1902*

5.46 The remains of the Penny Rigg crusher house (400) adjoin the wheel pit to the south; the two would have originally formed an integral unit. The west wall (401), essentially a retaining wall constructed against the hill slope, is built over the south-west corner of the wheel pit and overlaps the southern edge of holding pond wall (312). The south wall (407) is a freestanding gable end and is associated with two angled track ways (416), (417), which enter the building from the south-west. The east side of the building was open-fronted. Like the rest of the buildings in the complex, the crusher house is built of random-coursed slate rubble. Joist holes and other structural voids also indicate the extensive use of timber in construction.

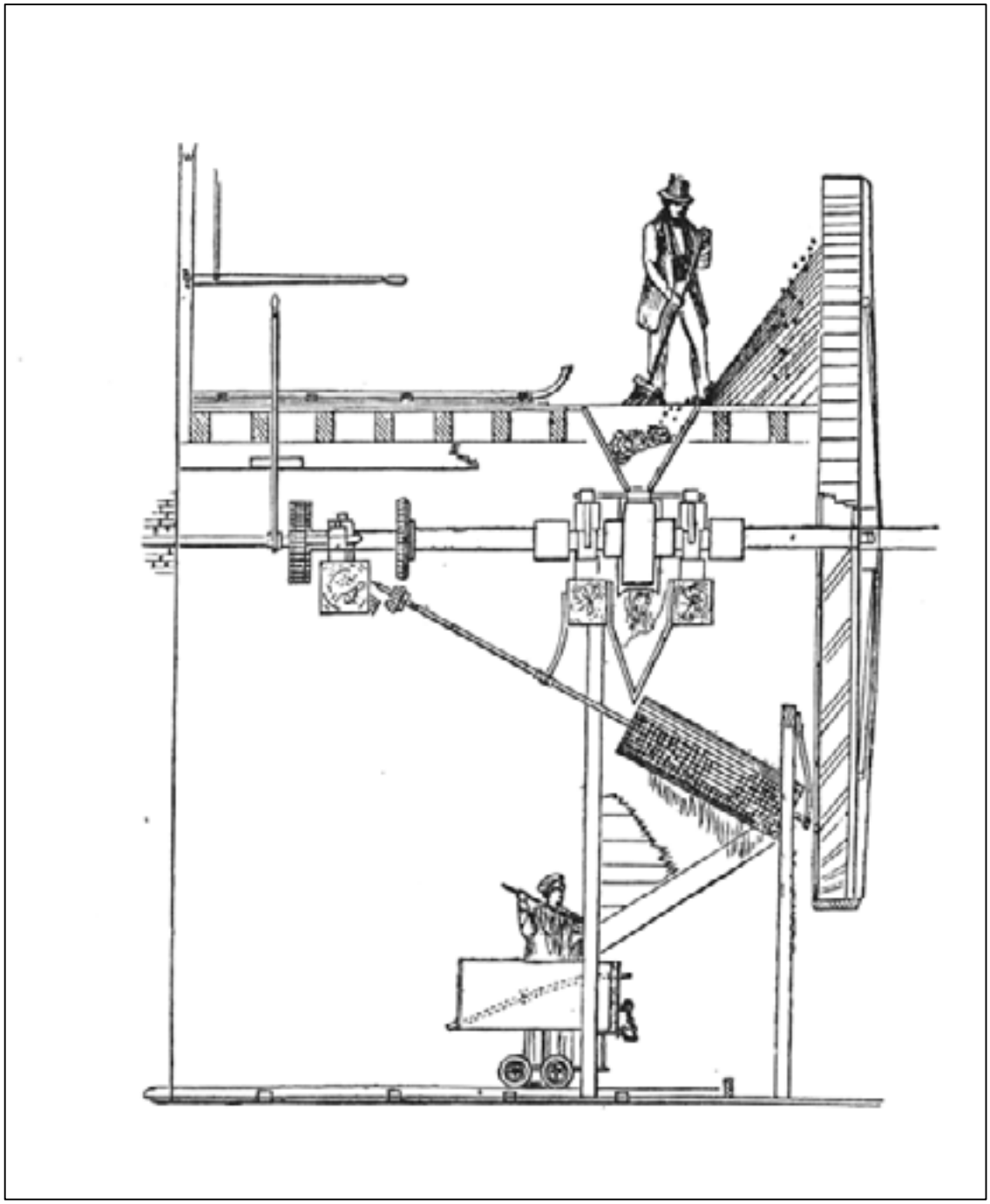


Figure 30: *Cut-away section of a crushing mill from John Pepper's* Playbook of Metals*, 1861. It shows the ore being fed into the hopper above the rollers, the trommel worked by gearing on the waterwheel axle and, to the right, the raff or elevator wheel*

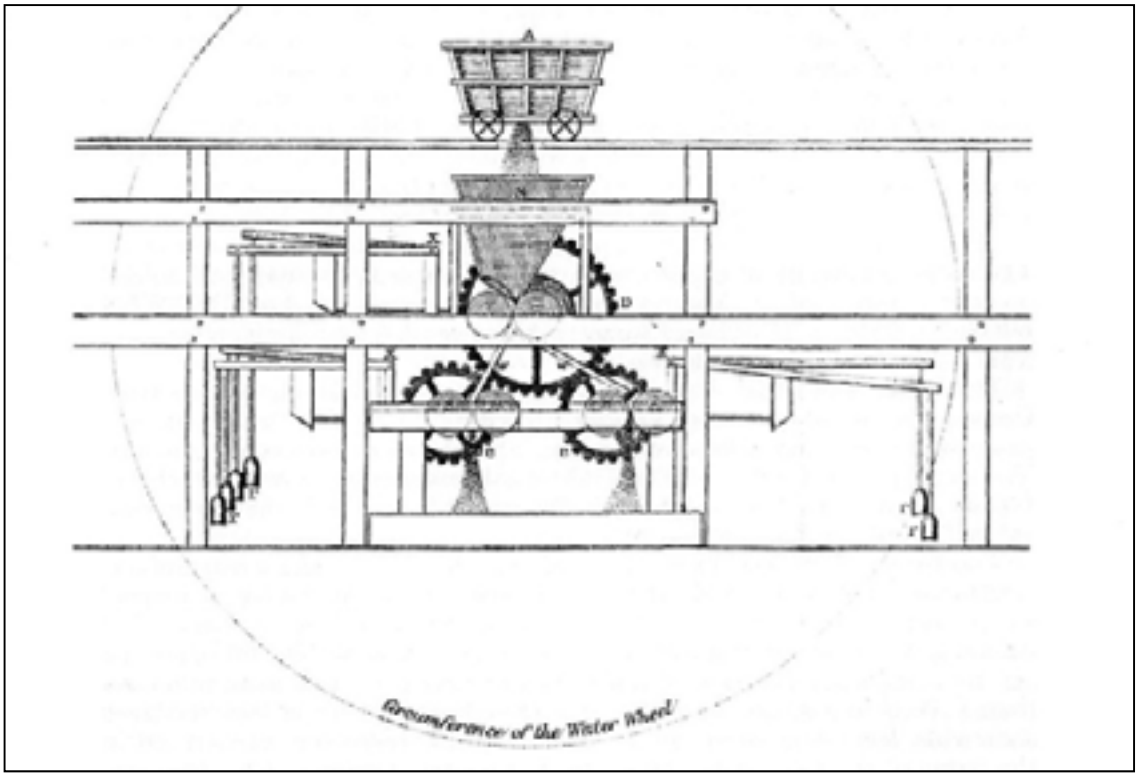


Figure 31: *Cut-away drawing of a set of three water-powered crushing rollers from Westgarth Foster's* Treatise on the Section of the Strata from Newcastle-upon-Tyne to Cross Fell*, 1883. The use of more than one set of rollers allowed ore to be crushed to different sizes. This example was used at the lead mines on Alston Moor, Cumbria in the early 19th century*

5.47 Set below the wall head of the east-facing wall (401) are a set of five rectangular joist holes (402), which correspond with a horizontal recess (408) on the north- facing wall and must relate to a timber floor spanning the interior of the building (Plate 31). This would have been accessed via entrance (409) in the south-west corner of the building, which connects with external track way (416) (Plate 33). There is, however, no surviving evidence of floor supports on the east and north sides of the building, although presumably these would have comprised a series of braced timber uprights. It is possible that the ground level void (405), at the north end of wall (401), was for one end of a horizontal sleeper beam holding vertical support timbers. Similarly, voids (403) on wall (401) may have held horizontal members relating to the north side of the same putative wooden structure. This structure must also have supported the north side of the crusher house gable roof. Recesses for roof trusses can be seen in the gable end wall (407), presumably connected with a matching timber gable to the north.

5.48 Evidence for a timber gantry of some form along the east side of the crusher house is indicated by voids (411), located at the east end of wall (407). Two lower joist holes

(404) at the south end of wall (401) may be associated with supports for an internal partition, or possibly a mezzanine stage or platform. A comparatively robust timber framework would have been needed to support both the iron roller crushers and the extended axle of the waterwheel. There is considerable potential that evidence associated with such a gantry, and any associated structures, would be uncovered during sub-surface archaeological investigation.

Plate 31: *east-facing wall of the crusher house (401), with first floor joist holes (402). The ground floor void (405) can be seen at the base of the vertical ranging rod*

5.49 The documentary evidence (see 2.22 and 4.23 above; Shaw 1971, 34) indicates that stamps were also employed for ore crushing at the Penny Rigg mill. A basic stamp mill comprised a set of vertical timbers with heavy iron-shod bases, which were raised and dropped on to an iron plate where the ore was pulverised. They were used to crush particularly hard ore and also for re-crushing jigged material. At the nearby Greenburn copper mine, the stamps were operated by the same waterwheel that powered the roller crushers and a similar arrangement may have been tried at Penny Rigg. The Greenburn stamps were located on one side of the wheel pit and the crusher was housed on the opposite side; the internal dimensions of the stamps and crusher buildings were 5.50m x 5.50m and 3.50m x 4.50m respectively (Oswald 2001, 81). There is no evidence at Penny Rigg for a separate stamps building on the north side of the wheel pit, but the internal dimensions of the crusher house (6m x 8.5m) appear large enough to have held

both roller crushers and a set of stamps. The stamps, presumably operated by cogged gears on the end of the waterwheel axle, are likely to have been located at ground level in the south section of the building and the putative timber partition mentioned above (5.48) may have separated the stamps from the crusher. The low-level opening (410) in the south wall (407) of the crusher house is associated with inclined track (414) (Plates 32-34) and could have been used to deliver particularly hard material direct to the stamps from the ore bins. The lower section of opening (410) was subsequently blocked (413), but this may post-date the abandonment of the mill.

Plate 32: *view of the southern gable of the crusher house showing the rectangular opening (410) and associated track way (414). The three retaining walls (417/418) and (415) are also visible*

5.50 Abutting the exterior or south-facing side of wall (407) are three retaining walls (419), (417/418), (415) that support, or enclose, two inclined track ways (416), (414). As noted above, the track ways were used to deliver material – principally hand-sorted ore – to the crusher and stamps and must have been associated with one or more ore hoppers, now buried beneath slate tip (813). At the base of the lowest retaining wall (415) is a small culvert outlet topped with a substantial stone lintel (420). This was associated with hillside drainage, especially in the area covered by the copper tips. A small length of retaining wall to the east (421) probably marks the line of the culvert's outflow channel.

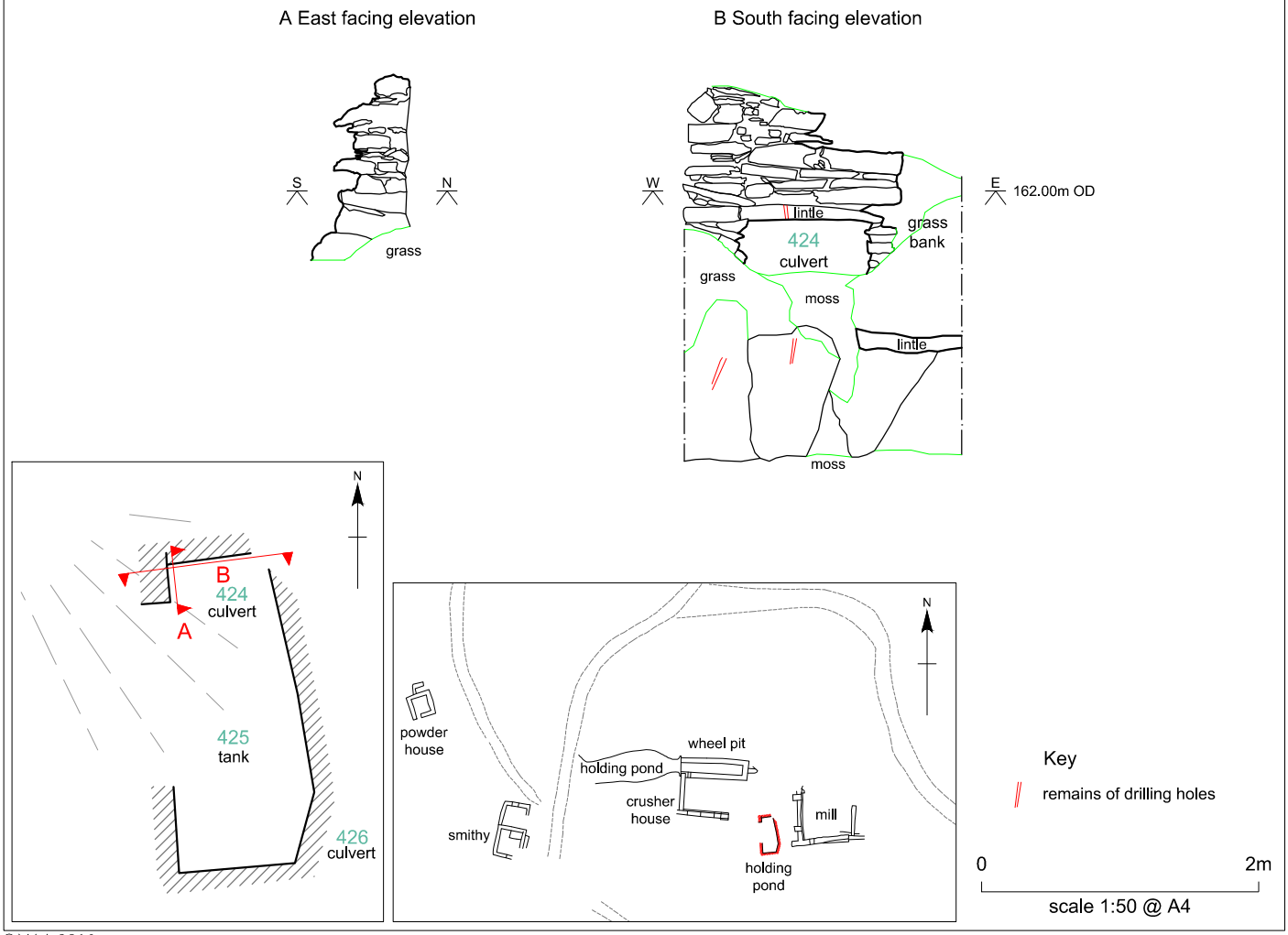

Plates 33, 34: *tracks above the crusher for delivering ore: (left) upper track (416) delivering material via opening (409) and (right) the lower track (414) associated with the lower level opening (410)*

Water outflow from the crusher (Fig. 32)

5.51 Excess outflow water from the crusher wheel was fed into leat (308/09) and taken off site, but any water that could be re-used elsewhere in the mill complex was diverted into culvert (424), presumably via a sluice gate; fragments of timber, associated with a sluice or launder, were observed *in situ* at the southend of the culvert. The culvert drained into a rectangular stone-sided tank (425), cut against a bedrock outcrop at the north end. In the south-east corner of the tank the water would have flowed into a short section of stone-slab culvert (426), incorporating the external corner of the dressing mill (500). The south side of this forms part of the support structure (523) for steps (524).

5.52 The line of any watercourse beyond the east end of culvert (426) is unclear. To the east is another short length of slab-roofed culvert (526) above retaining wall (527), which is probably associated, and indicates that the water supply ran parallel to the south-facing wall (507) of the dressing mill. The flight of stone steps (524) to the south-west lead down to a rectangular space defined by wall (507) and a parallel wall (525), which survives as a partial foundation course. The interior of this space is obscured by fallen rubble (Plate 35), but could have enclosed a pit or housing for the second waterwheel (12ft/3.65m diameter) listed in the 1875 sales inventory. If this interpretation is correct, then tank (425) would have been a holding or control pond for a wheel, positioned below the east end of culvert (426).

Culvert opening between the crushing house and the mill



Penny Rigg copper mill, Cumbria: holding pond and culvert opening *Figure 32*

Plate 35: *looking west along the exterior of the south wall (507) of the dressing mill. The rectangular platform in this location (approximately the same width as the ranging rod) may be the backfilled remains of a smaller wheel pit associated with the mill*

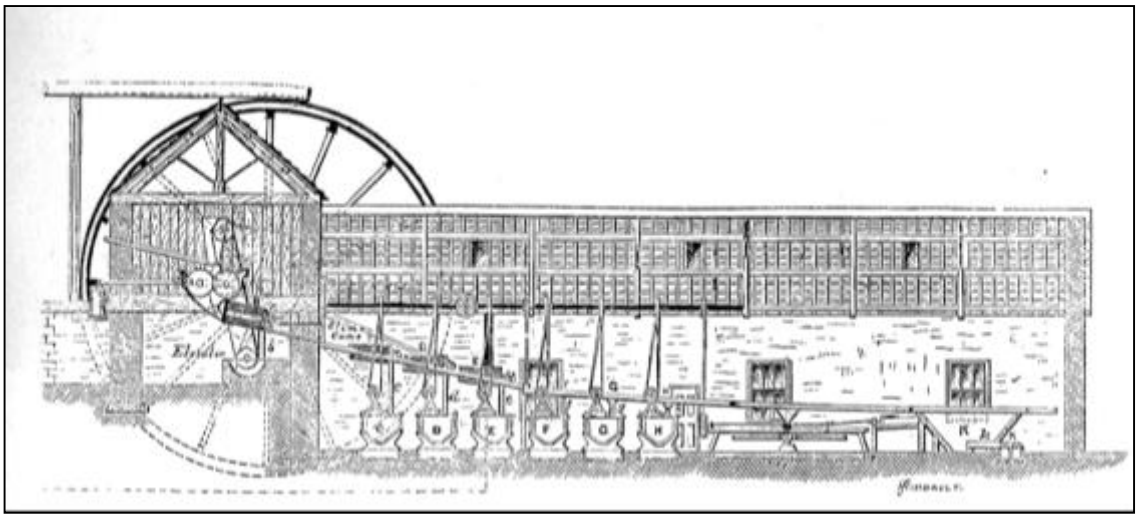


Figure 33: *section of a water-powered dressing mill from E.H. Davies'* Machinery for Metalliferrous Mines*, 1902. The ore crusher is to the left and within the mill is a set of six mechanised jigs powered by belt drive from a line shaft. To the right is a rotary buddle (not used at Penny Rigg)*

5.53 A second wheel in this location would have powered a set of mechanised jigs within the dressing mill such as those illustrated on Figure 33. However, there is no evidence to

suggest that the opening in the south wall (510) ever supported a waterwheel axle, although a gear-operated line shaft(s), powered by the wheel, may have passed through it into the dressing mill. Steps (524) would then have provided access to the wheel from above, and the outflow water from the wheel would have been carried away through culvert (526).

Stage 4: Dressing the ore

5.54 Once the ore had passed through the crusher, the finely crushed material was taken to the dressing mill where the valuable ore was separated from the waste in 'jigs'. These were water-filled wooden tanks with internal sieve boxes. Simple jigs were operated by hand, but by the mid-19th century most were mechanised, worked by a crank shaft and line drive attached to a waterwheel (Fig. 33).

5.55 The crushed ore was shaken and sorted in the jigs with the heavy copper or 'heads' settling at the bottom; this was pure copper and could be bagged ready for smelting. A mixture of stone and mineral known as 'middlings' formed in the centre and could be jigged again to achieve a finer separation and, depending on size, might also be re-crushed.

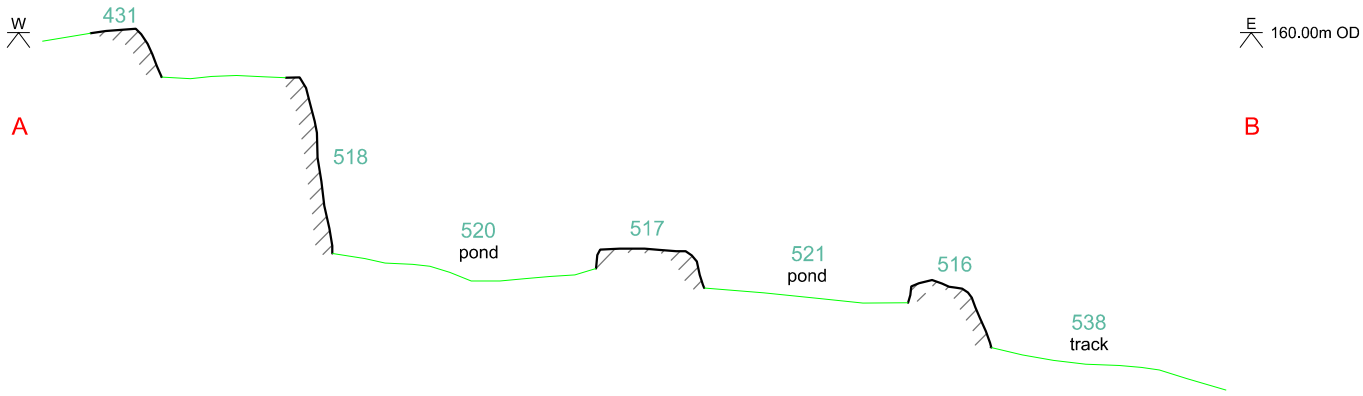
The dressing mill (500) (Figs 35, 36)

5.56 The dressing mill (500) at Penny Rigg was constructed on a terrace directly below the crusher. Ore was tipped into the building via two high-level timber hoppers (associated with angled recesses (504), (505) located on the west wall (501) (Plate 35) and the jigs must have been located immediately in front of these. The number of jigs is unknown, but a set of four could have been accommodated in the space available. The 1875 sales inventory lists a second waterwheel and it is probable that this powered the jigs in the dressing mill. The exact location of the wheel is still a matter of debate, but is likely to have been at the south end of the building (against the external face of wall (507)).

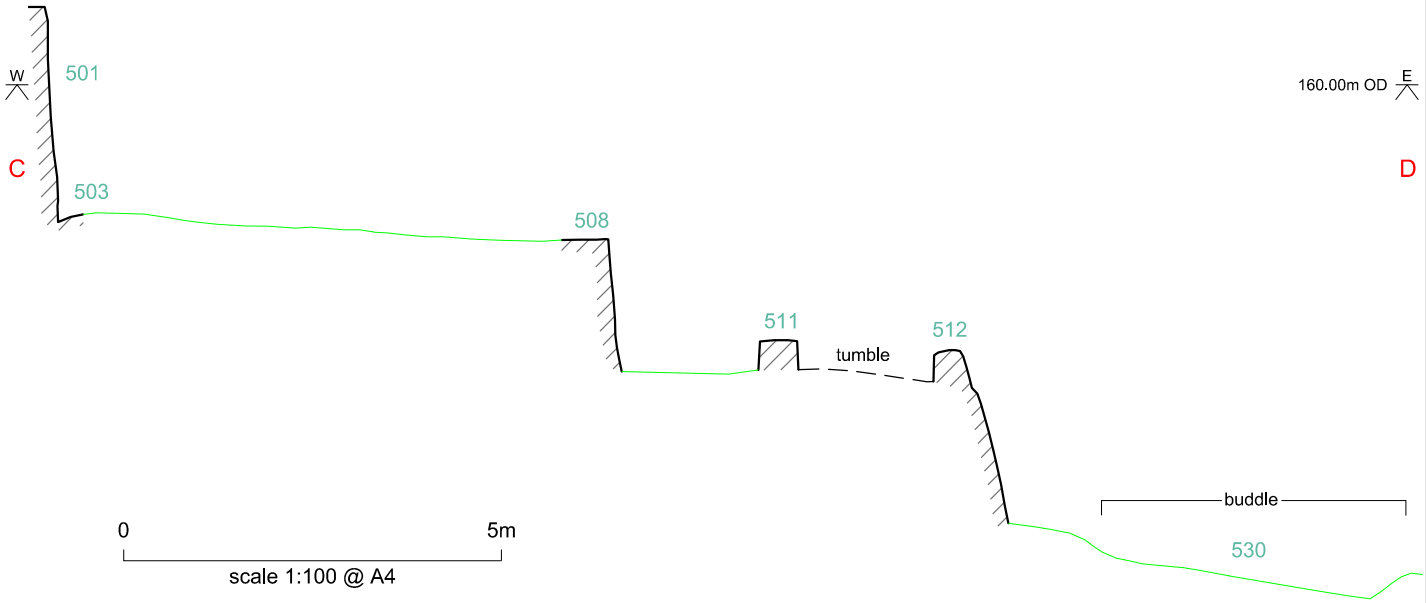
5.57 The principal surviving elements of the dressing mill are the west retaining wall (501), the freestanding south wall (507), two terrace retaining walls (508), (513) and a secondary structure formed by walls (511), (512), (515). The mill, which is shown as a roofed structure on the *c.* 1869 Lampton map (Fig. 8), encloses two adjacent terraces, with a difference of 1.70 m between the two floor levels.

Mill and associated structures

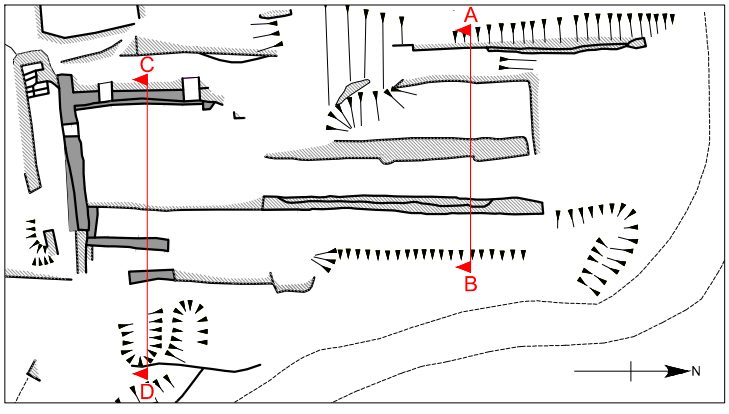
Profile section across the north end of the mill



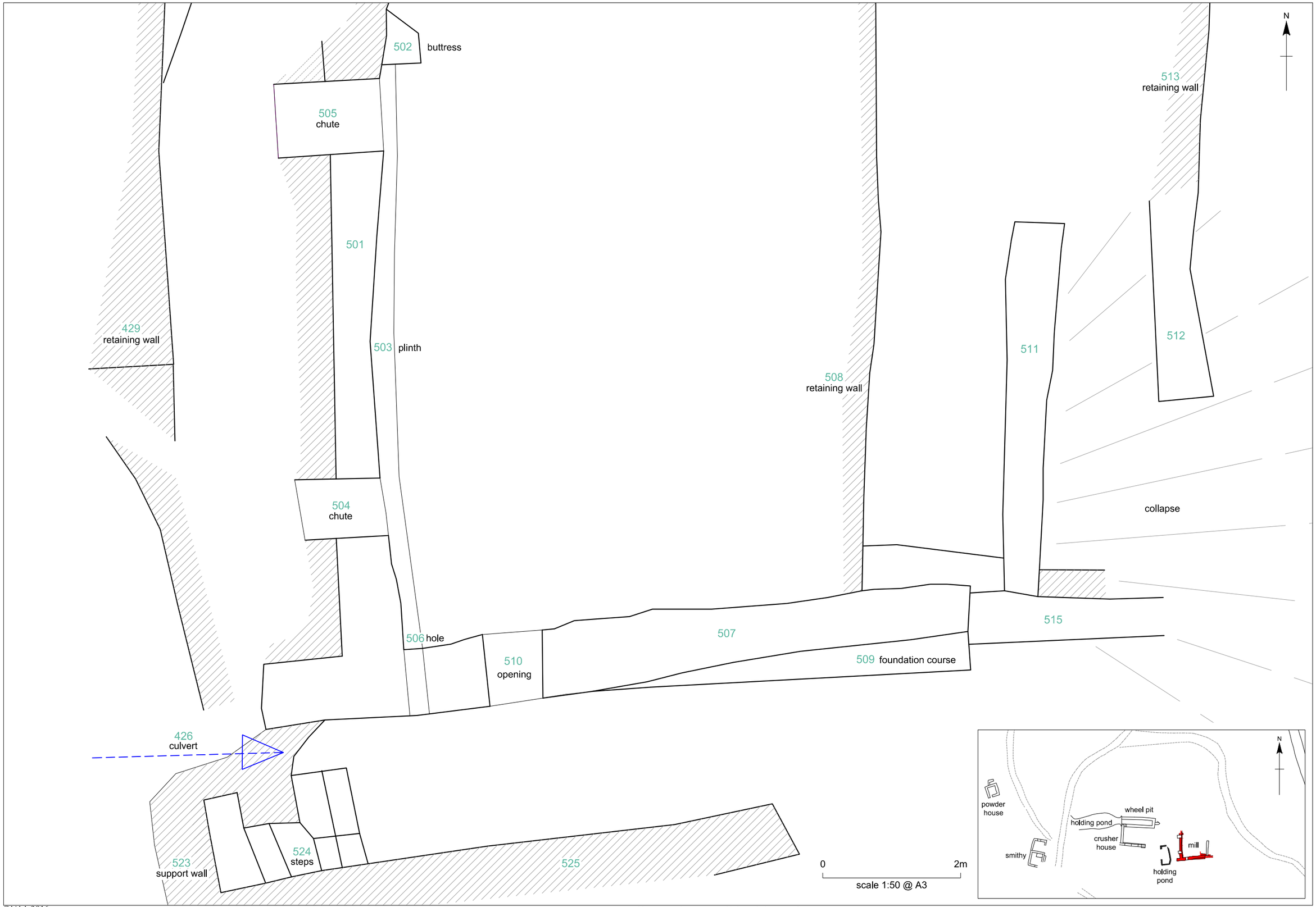
Profile section across the south end of the mill



Plan showing the location of the profiles



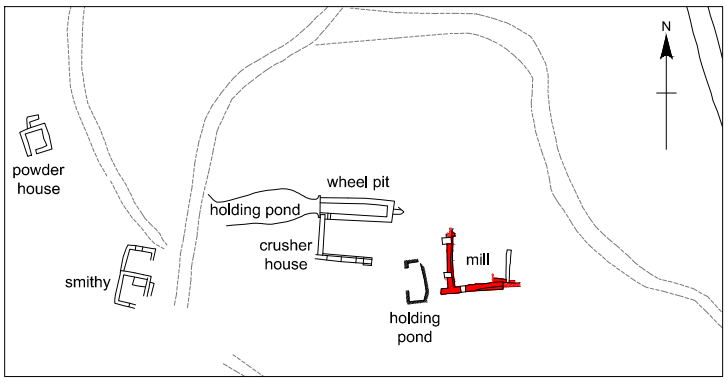
Penny Rigg copper mill, Cumbria: profile sections across the mill *Figure 34*

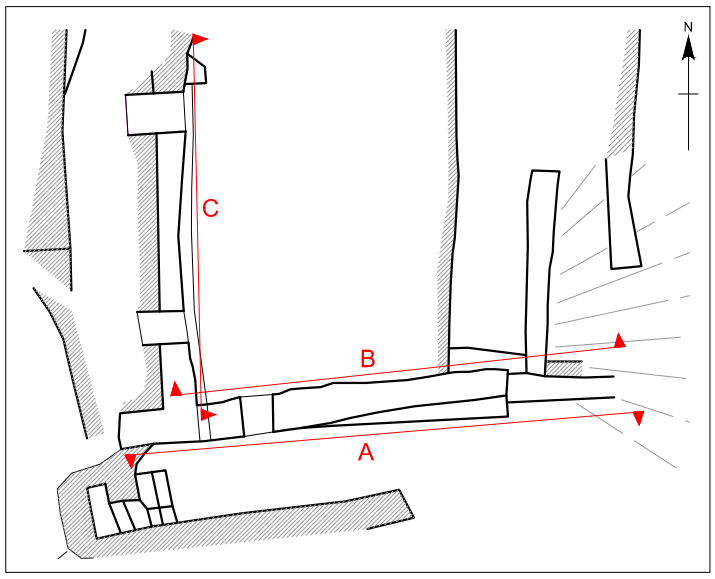


Penny Rigg copper mill, Cumbria: mill building plan

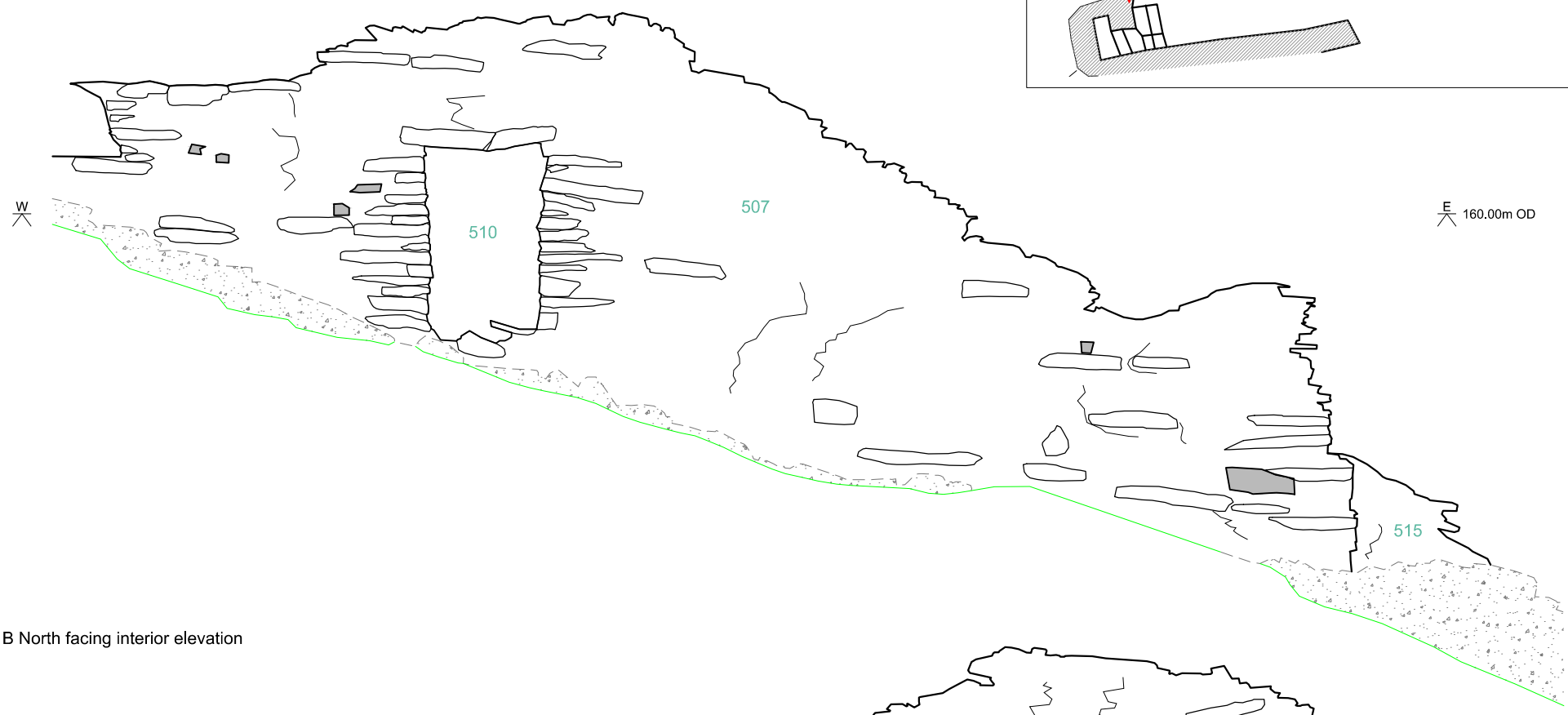
Figure 35

Mill - interior and exterior elevations



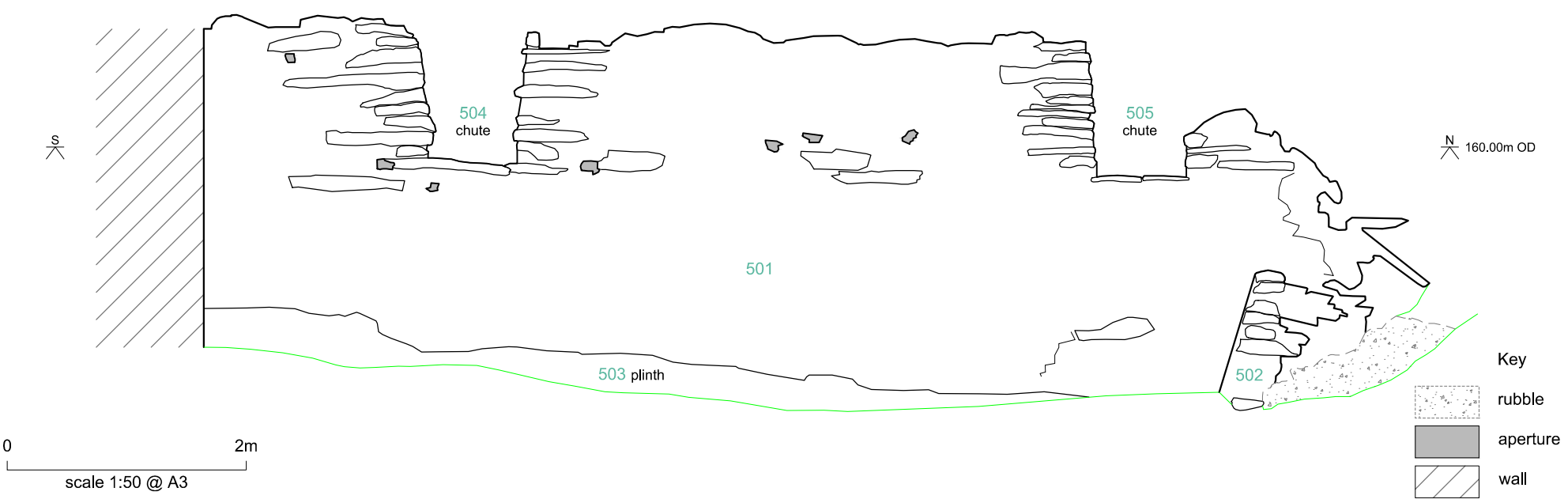


A South facing exterior elevation



B North facing interior elevation

C East facing interior elevation



Penny Rigg copper mill, Cumbria: mill elevations

Figure 36

5.58 The west retaining wall (501) was built into the natural slope of the hill and is separated from the crushing house by a short length of retaining wall (429). Set into the wall-head of (501) are the two rectangular recesses (504), (505) (Plate 35), which delivered ore from the crusher into jigs positioned within the interior of the dressing mill. At the base of (501) is a low stone plinth (503) that connects with a small rectangular opening (506) to the south. To the north of this is a similarly sized opening, running through the back of buttress (502). Both of these probably held supports for a wooden trough or launder diverting water from the channel on the south side of the dressing mill to the settling ponds (520), (521) (Plate 36). Wall (501) has collapsed to the north and its full extent is unknown, although it probably corresponds to the north end of retaining wall (508), which runs in parallel.

Plates 36: *angled recess (504) in wall (501); one of two chutes for tipping crushed ore from the crusher into the dressing mill*

5.59 Wall (507) forms the south end of the dressing mill. At its east end it is built on a foundation course (509) that butts against terrace wall (508) and at its west end bonds with wall (501). Wall (507), which curves inwards at the east end, stands to its original height, and the surviving profile indicates a double, or M-shaped, gable. Above opening

(510) is an off-centre gable, which slopes gently to the west to join with the wall-head of wall (501). It slopes more steeply to the east where it forms a valley above terrace wall (508) and then rises again to a lower gable close to wall (511). The east end of wall (507) does not survive, but a vertical joint, overhung by the remaining section of the second gable, suggests there may have been a door or window at this point.

Plates 37, 38: *(left) stone plinth (503) for carrying the launder channelling water to the settling ponds, and (right) north-facing elevation of south wall (507)*

5.60 The double gable may indicate that there was a sloping roof covering the principal internal area west of retaining wall (508). A second, smaller and comparatively narrow, gabled roof would have extended across the lower area, between retaining walls (508), (513). There is no indication of standing walls at either the east or north end of the dressing mill and it is likely that these sides were open, with the roof supported on freestanding timbers.

5.61 Butting against foundation wall (509), and partially replacing the collapsed east end of mill wall (507) is a rectangular three-sided structure formed by walls (512), (513), (515). These are of comparatively poor build, using friable stone slabs, with no obvious sign of mortar. The structure clearly post-dates the construction of the dressing mill, but it cannot be established if it is contemporary with or later than the mill's operational life. It may have been a store or workshop.

Plate 39: *view of dressing mill and crusher looking south-west and settling ponds in the foreground*

Plate 40: *western settling pond (520), one of two to the north of the dressing mill. Water still pools in the base of the feature*

5.62 A catalogue of ore dressing plants in the Lake District (Shaw 1970, 34-5) lists a set of stamps at Penny Rigg, and there are also references in the goods received notebook to

stamps being delivered to Tilberthwaite (AMATL 2016.881). Water- powered stamps are known to have been in use at the Paddy End and Bonsor mills at Coniston by the 1830s. These were predominantly used to crush the waste material from jigging and were often located close to the buddles. This is true of Penny Rigg, where the stamps were probably installed in front of retaining wall (527), at the south-east corner of the dressing mill, adjacent to the buddles.

The settling ponds (520), (521) (Fig. 11)

5.63 Immediately north of the dressing mill, and on the same terrace, are two rectangular features (520), (521). These are settling ponds where the re-worked middlings and the fine waste drained from the jigs was taken, and any remaining copper ore was allowed to settle to the bottom. The settling ponds were periodically drained and the mineral-rich material and sludge at the bottom of the tank taken for treatment in the buddles (528), (530), (531) located below the dressing mill was washed in an angled trough known as a box buddle.

Plate 41: *eastern settling pond (521) and associated stone-faced banks (516), (517)*

5.64 The two Penny Rigg settling ponds are at different heights and connected by a drain (522) at the north end. The upper (west) pond (520) measures *c.* 12.00m by 3.75m and the lower (east) pond (521) measures 17.00m by 3.15m; both are now drained. The ponds

are separated by a low stone-banked wall (517). Drains or launders would have originally connected the jigs and ponds, but the bank between the mill and ponds has collapsed, burying any surface archaeological evidence.

5.65 Pond (520) is defined to the west and north by two substantial retaining walls (518), (519), which have been terraced into the hill slope. The east edge of pond (520) is formed by retaining wall (516) and its inner face has been constructed with carefully set angled slabs. The reason for this style of construction is not apparent, but may relate to permeability. Both ponds are connected by a narrow channel or drain (522). A simple sluice gate in this location would have presumably controlled the flow of water and mud from one pond to the other. The ponds are shown without roofs on the Lampton map and there is no visible archaeological evidence to suggest this area was ever covered.

Plate 42: *rectangular depression (528) associated with buddle. Stepped stone sides remain visible*

Buddles (528, (530), (531) (Fig. 11)

5.66 Set in the bank to the east and down slope of retaining wall (513) are three sunken rectangular features with sloping floors (528), (530), (531) that are best interpreted as box buddles. Material from the settling ponds would have been transported as slurry – presumably in a now-lost wooden box drain or launder – to the three buddles (528), (530), (531) situated on the slope below the dressing mill. The material was raked against

a constant flow of water and the lighter waste was washed away leaving the heavier, mineral-rich sand at the top of the buddle. By the mid-19th century, most new ore dressing mills (including the Bonsor and Paddy End mills at the Coniston mines) had mechanised round buddles, so the use at Penny Rigg of hand-operated box buddles is somewhat anachronistic.

5.67 Buddles (530) and (531) are parallel to each other, both featuring a low retaining wall to the east. Buddle (528) is in the centre of a raised mound with a curved retaining wall (529) at its east end. The area dividing buddle (528) from the other two has been disturbed by recent flood damage, which has obscured the relative settings of the features. However, this has served to expose deposits of fine, laminated sands in the bank sides, the waste product of buddling. Turf masks internal features within the buddles, but internal stone edging possibly survives in association with buddle (528). There also appears to be a stone-sided drain running from the east end of buddle (530) to retaining wall (533).

5.68 A system of drains and/or timber launders must once have been in place to take mineral-rich waste and slurry to the buddles from the jigs and settling ponds. The only surviving evidence for such a system is a curved depression (537) on the slope between the north end of retaining wall (516) and track (705), which could be interpreted as part of a drain system linking the settling ponds and buddles.

5.69 Water to supply the buddles must have come from culvert (526), taken over the retaining wall in a wooden launder. Down slope of buddle (528) are two truncated sections of culvert (534) and (535); this is all that survives of the watercourse leading from the dressing mill to the tailings pond and the beck.

Stage 5: Storing the copper ore

5.71 Copper ore ready for smelting was produced at a number of stages during the dressing process: solid chalcopyrite was collected during hand-sorting, jigging produced smaller-sized ore, and buddling resulted in a fine ore-rich sand or concentrate. At most mines, the ore was stored in a building known as a copper house and such a structure is listed in the 1875 Penny Rigg sales inventory. None of the surviving buildings can be identified as a potential copper house, but the Lampton map shows a comparatively large L-shaped structure south of the crusher house. This building does not appear to fit into the ore dressing sequence, but it could certainly have been used for ore storage (and also

perhaps have provided additional office space). This building is now completely buried by later slate spoil, the only surviving evidence being a paved surface (423) and two retaining walls (417), (428).

5.72 The paved surface is located to the south-west of the crusher house on a level area adjacent to tank (425). It comprises a series of large stone slabs (423), but the full extent of the feature cannot be established because it is covered by the later rid tip (813). The north edge of the feature appears to correspond with the large L-shaped, roofed structure depicted on the 19th-century Lampton map (Fig. 8). There are no signs of wall footings surrounding the paved area, which suggests that the structure, or at least this section of it, was of timber frame construction. Retaining walls (427), (428) may be part of the same building.

Plate 43: *large stone slabs to the south-west of the crusher and possibly associated with the L-shaped structure shown on the Lampton Estate map*

Stage 6: Disposing the waste

5.73 Waste material was produced at each of the processing stages. The primary waste – deads – resulting from driving the level and mining the ore body was dumped at the

north end of the site, tip (107). Waste from hand-sorting, and possibly from crushing, formed a second spoil tip (539) lower down the hillside. Both of the tips have been partly buried under later slate spoil, which obscures their original form and size.

Plate 44: *mining tips – in the foreground, waste from hand-sorting and crushing (539), and in the background, tip (107), associated with primary sorting*

The tailings pond

5.74 The waste – or tailings – from the buddles formed fine sand, which, together with the tailings from the jigs and settling ponds, was disposed of in an embanked pond or lagoon on the west of Yewdale Beck (600). Most mine tailings contain toxic particles and pollution of nearby watercourses was a constant risk. Until the mid-19th century, the disposal of mining waste was self-regulated, but with the introduction of the Rivers Pollution Prevention Act of 1876 mine owners were specifically prohibited from discharging waste into streams *'unless he proves that he is using the best practicable and reasonably available means to render such matter harmless,'* (Le Neve Foster 1894, 667). The embanked tailings pond at Penny Rigg would have effectively contained the waste, which suggests the company was either aware of best practice in dealing with pollution risks or else was responding to the requirements of the new Pollution Prevention Act.

> The large amount of refuse which is produced in extracting some minerals from their ores, makes the task of getting rid of it, without polluting the rivers, far from easy; and the miner often incurs the wrath of the fisherman, who stirs up the Sanitary Authorities or River Conservancy Boards into action. Coarse waste, such as comes from jigging the larger sizes of the crushed rock, can always be made into heaps upon the land; but the fine slimes, whether coming from stamping or other dressing processes, are carried away in suspension, and turn a bright trout stream into a muddy drain, or are spread over the meadows in flood time, to the annoyance of the farmer. These evils may be greatly lessened by providing large pits into which the water from the mine is allowed to settle, and so deposit much of the solid matter which it contains in suspension.
>
> Le Neve Foster, C. (1894) *Text-Book of Ore and Stone Mining*

5.75 Evidence of the tailing pond comprises a series of earthwork banks (600) identified between the modern road and Yewdale Beck. A large earth bank or levée (601) separates the pond from the beck, with stone revetting on the west side and a double stone face on the east- or beck-facing side (Plate 45). Flood damage has truncated the bank in two sections revealing parallel boulder foundation footings with an internal fill of earth, turf and occasional river cobbles.

5.76 The north side of the pond is defined by an earth bank (604) running at right angles between the beck-side bank (601) and the bottom of the slope, while the west and south sides are formed by a combination of natural slope and terraced retaining walls (602) and (603). A natural watercourse, enhanced originally by drainage from culverts (534) and (535), is carried under track (705) in a well-preserved stone-slabbed culvert (536) and enters the pond from the west. The channel now enters the beck through a breach in bank (601), but originally would have run out across an overflow channel (606) constructed at the south end of the bank. The overflow channel is set just below the top of the bank and allowed water, but not waste material, to flow into the beck from the pond.

5.77 A gap (607) between bank (604) and the beck-side bank (601) may indicate the position of a sluice gate and seems to be associated with a secondary pond (605) positioned north of the main one (Plate 46). The east edge of the putative pond is defined by a continuation of bank to the north (601). The secondary pond may have been designed to hold accidental waste, perhaps material washed away from the copper mill during floods and storms. The bank prevented discharge into Yewdale Beck and a sluice in gap (607)

would then have allowed contaminated material to be channelled into the main tailings pond.

Plate 45: *earth bank or levée (601) separating the tailing pond from Yewdale Beck*

Plates 46, 47: *(left) gap (607) at east end of bank (604), possibly associated with a sluice or overflow, and (right) low, discontinuous retaining wall forming curved S-section of tailings pond (602)*

5.78 No evidence remains to indicate how waste was transported from the mill to the tailings pond. Some of the heavier buddling sands could have been moved by hand in barrows, while liquid waste must have been fed along leats or launders. It is unlikely, given the extent of flood damage in this area, that any archaeological evidence survives below surface.

Water supply

5.79 Nearly all of the ore dressing mills in Cumbria were water-powered and Penny Rigg was no exception. The Lampton map (*c.* 1869) illustrates the arrangement of the original water management system (Fig. 7). Water for the crushing mill wheel was conveyed via a leat from Tilberthwaite Gill into the flooded Penny Rigg quarry, which acted as a reservoir. It was then carried via adit (815) along another leat (317) to the wheel. The final section of (317) survives as an embanked channel, with an overflow sluice (318). The leat leads to a raised holding pond (310) directly above the wheel. Water draining from Horse Crag Level was also diverted to the holding pond via culvert (103/306), although the final section of this watercourse no longer survives.


Plates 48, 49: *(right) leat (308/309) running down to Yewdale Beck, and (left) culvert (424)*

5.80 Depending on need, outflow water from the crusher wheel pit was carried into one of two culverts. Surplus water not needed elsewhere in the mill complex was then taken north via culvert (306) to leat (308/309) (Plate 48). This discharged directly into the channel running down slope to Yewdale Beck. Outflow water that could be re-used was channelled south through culvert (424) into a small holding tank (425) (Plate 49) and then led east along the outer wall of the dressing mill where it may have powered a second waterwheel. From there, the water flowed down slope in a series of culverts to the tailings pond (600) and thence, via overflow channel (606), into Yewdale Beck. At

some point close to the north-east corner of the dressing mill, water must have been taken from the main watercourse to the three buddles (258), (530), (531) but nothing survives to indicate how this was achieved.

5.81 A water supply was also needed for washing the ore at the ore bins, to supply the jigs, and for filling and controlling the settling ponds. There is little surviving archaeological evidence for these secondary water features, although culvert (420) may be a drain from an ore washing area further west and linear feature (501) in the dressing mill could be associated with water supply to the jigs and ponds

Access and transport

5.82 Movement of ore from the mine to the copper mill would have been by tubs running on iron rails, but most evidence for this has been obscured by later dumping and spreading of slate spoil. The only indication of a contemporary tramway at the surface is at the south end of copper tip (107) where three parallel tip lines with distinctive 'finger' outlines appear to have been formed by dumping waste from tubs running on temporary or moveable rails. However, there is a long section of tramway preserved within the level (Plate 50).

Plate 50: *mine tub surviving* in situ *in the Horse Crag Level. Photograph courtesy of Warren Allison*

5.83 Two of the surviving tracks (701), (705) appear to be associated with the mine and copper mill. Track (701), now overgrown, partly covered by slate tip (814) (Plate 51) and cut to the south-west by later track (700), is shown on the First Edition Ordnance Survey 6-inch map of 1850 (Fig. 5) as linking the entrance to Horse Crag Level with the valley road. At this date, the copper mill had not been built, so it can be assumed that the track was constructed specifically to serve the mine. It is comparatively narrow (*c.* 2.00m wide) and one of the surviving sections includes a well-constructed stone-slab bridge (702). The bridge crosses the overflow watercourse from leat (317) and may be a slightly later feature, contemporary with the construction of the waterwheel at the crusher house.

Plate 51: *mine track (701), now overgrown and partially covered by waste from later quarrying*

5.84 The Lampton map (Figs 7, 8), shows track (701) and depicts another track curving uphill from the valley road, passing the north end of the settling ponds and terminating at the crusher house. This track must have been constructed to access the mill complex and is thus probably contemporary with it. It survives as a broad grassed track (705) (Plate 52), which in its upper section is terraced into the hill slope. Feature (432), a narrow terrace connecting with and running above retaining wall (431), is probably an access track to the crusher house and may originally have been part of track (705). A similar track is likely to have run along the terrace below the settling ponds and provided access to the lower section of the dressing mill, but nothing survives.

Plate 52: *second of the original mine tracks (705), constructed to access the mill complex*

5.85 All of the other tracks appear to be later and are connected with slate quarrying. This includes the final or western section of track (705), which cuts across, and so post-dates leat (308/09), and joins with mine track (700); this extension clearly belongs to a period after the closure of the copper mill.

5.86 The processed copper ore is likely to have been transported on carts down the valley to the copper quay at Coniston Hall. All of the Coniston ores were shipped down the lake to the store or copper house at Nibthwaite, then carted to the copper yard on the Ulverston Canal (Holland 1987, 87). Alternatively, it may have been carted to Kirby Quay, which is a shorter route (I. Matheson *pers. comm.*).

Slate quarrying

5.87 Nearly all the other features at the Penny Rigg site relate to later slate quarrying. These include the Horse Crag Quarry tips (811), two riving sheds (800), (812) (Plates 53, 54), the lower slate tips (813), tracks (700), (704), the loading ramp and compressed air pipe (104), (105) close to the mine smithy, and probably also linear feature (106) between the smithy and the powder house. The principal slate quarrying features are included in the site inventory, but a more detailed list can be found in the 2010 Conservation Management Plan for the mill and quarry (Archaeo-Environment 2010).

Plate 53: *east-facing open-fronted riving shed (800)*

Plate 54: *north-east-facing elevation (front) of riving shed (812)*

5.88 A small group of slate quarrying features centred on tip (814) may, however, be contemporary with the later phase of working of the copper mill. Rid tip (814) derives, at least in its original form, from Quarry Level (815), which was driven north-west to drain

Penny Rigg slate quarry and provide a new supply of water to the mill complex. The original leat (317) is carried beneath tip (814) in a culvert (319) and this demonstrates that the leat – and by implication the copper mill – was still active when the tip was constructed.

5.89 A narrow embanked track (703) runs from the mine smithy to the entrance of Quarry Level. It is not shown on the 1850 Ordnance Survey map, but could be contemporary with the driving of the level and then remained in use as an access route to Penny Rigg quarry.

5.90 The rectangular, open-fronted riving shed (800) in front of Quarry Level is harder to date (Plate 53). Possibly the shed was used to treat workable slate derived from the driving of Quarry Level, but it is perhaps more likely that it relates to a later reworking of Penny Rigg quarry when slate was brought out through Quarry Level for processing and dumping.

6.0 STATEMENT OF SIGNIFICANCE

6.1 The heritage significance of Penny Rigg copper mill derives from a wide range of varying values and perspectives, encompassing not just the physical fabric of the mine and mill, but also its setting, use, history, traditions, local distinctiveness and ability to bring together local people and communities. All of these elements are at risk from change – either via direct action (e.g. development, planting, renewed quarrying), or inaction (e.g. abandonment and collapse) – with potentially dramatic consequences on the heritage significance of the complex.

6.2 The following section updates an earlier assessment made as part of the 2010 Conservation Management Plan (Archaeo-Environment 2010). It considers the significance of the copper mill according to four high-level themes as set out in *Conservation Principles, Policies and Guidance for the Sustainable Management of the Historic Environment* (English Heritage 2008):

- Evidential Values – the potential capacity of the mill to yield primary evidence about past human activity (layout, rarity, group value, extent of survival, etc.).

- **Historical Values** – the potential of the site to advance the historical narrative – the connection between the present and the past through association with people, events and aspects of life.
- **Aesthetic Values** – the potential for people to derive sensory and intellectual stimulation from a place, through design, art, character, and setting.
- **Communal Values** – the potential for the site to bring people together through collective experience or memory.

6.3 Overall, Penny Rigg copper mill is considered to be of exceptional significance (regional and national) as a predominately single-phase mechanised ore dressing and processing site. Its historic value is closely allied to the development of Tilberthwaite mine, one of the earliest copper mines in the area, first founded in the late 16th century and remaining in operation – albeit intermittently – through to the late 19th century. There are also important historic and evidential parallels with the Greenburn mine further to the north and Coniston copper mine to the west, as well as Goldscope mine in the Newlands Valley, and smaller workings such as Long Work and Dale Head in the Newlands Valley, and Hay Gill and Carrock End in the Caldbeck Fells. These workings form part of the Cumbrian group of mines, which constitute the largest concentration of copper mines outside of Devon and Cornwall, and have had substantial impact on both the historic development of the region and the character of the surrounding landscape.

6.4 Within the Cumbrian group, there are a number of examples of ore-processing works, most notably the mills and dressing floors at Paddy End and at Upper and Low Bonsor at Coniston. However, what sets the Penny Rigg mill apart from these is the fact that it is largely a single-phase complex and was designed as a mechanised operation from the start, rather than adapting to advances in technology over a period of time. The quality of construction, comprehensive nature of the remains, and good preservation of the site, all contribute to making it of exceptional evidential value, and an exemplar of copper processing technologies in the latter half of the 19th century. There were a number of contemporary copper mills elsewhere in Cumbria, including Roughton Gill, Red Gill and Goldscope, but few standing structures survive at these sites today.

6.5 The Penny Rigg complex includes evidence of all of the key aspects associated with copper-ore processing, except for smelting, which was performed off-site. The processes include: gaining the ore (Horse Crag Level); sorting and ragging the ore (mineral-rich spoil tip near mine entrance); crushing the ore (crusher house and wheel pit); dressing

(dressing mill, settling ponds and buddles); managing waste (tailing ponds and spoil tips); transportation and movement around site (original mine tracks, steps, terraces); power transmission (wheel pit), and water management (holding pond, launders and various leats). In addition to the visible surface evidence, there is also high potential for the preservation of sub-surface archaeological remains, particularly in the areas associated with the crusher house and dressing mill. Underground mining remains are preserved within Horse Crag Level, including rails and tubs (W. Allison *pers. comm.*). In addition to the mine and mill remains, there is a large number of surviving features relating to historic quarrying in the area, including the closehead, riving shed, rid tips, and quarry tracks.

6.6 The historic values of Tilberthwaite mine and Penny Rigg mill contribute considerably to the significance of the site. Of particular importance in this respect are the various primary source documents held in the CATMHS archive at the Armitt Museum and Library, as well as those held in the Cumbrian Archives at Whithaven, Kendal, Carlisle and Barrow. A further detailed analysis of this material has the potential to expand our understanding and knowledge of the mine and mill's development, although there are a number of difficulties in interpreting the documentary material, not least that Coniston and Tilberthwaite are frequently combined as one in these sources.

6.7 The site has close connections with the life and works of the mining engineer John Barratt, and Penny Rigg copper mill can be seen as the culmination of his work and experience over 50 years in mining. The complex incorporates many of the advances in layout and technologies brought by Barratt and John Taylor from the Devon and Cornwall ore fields and refined over the years at Grassington and Coniston. There are also important links with the later owners, most notably Thomas Wynne, but also James Fleming who was probably responsible for a later phase of rebuild and modification, and Thomas Warsop.

6.8 The mill also keenly illustrates the often precarious nature of mining prospection. Despite the experience and past successes of men like Barratt, and a considerable investment in plant and labour, the Tilberthwaite venture ultimately failed, the mill being in operation for less than 10 years. The multiple reasons behind its failure – the fall in copper prices, technical difficulties in driving the level, issues of royalty ownership, underground collapse and rock slips, management of joint stock companies and the like – illustrate the multitude difficulties faced by mineral mining companies across the country, with the

number of failed mines probably equating, if not exceeding, successful operations such as Coniston and Goldscope. This contributes considerably to an understanding of the mineral mining industry as a whole, as well as to the industrial and social history of the area.

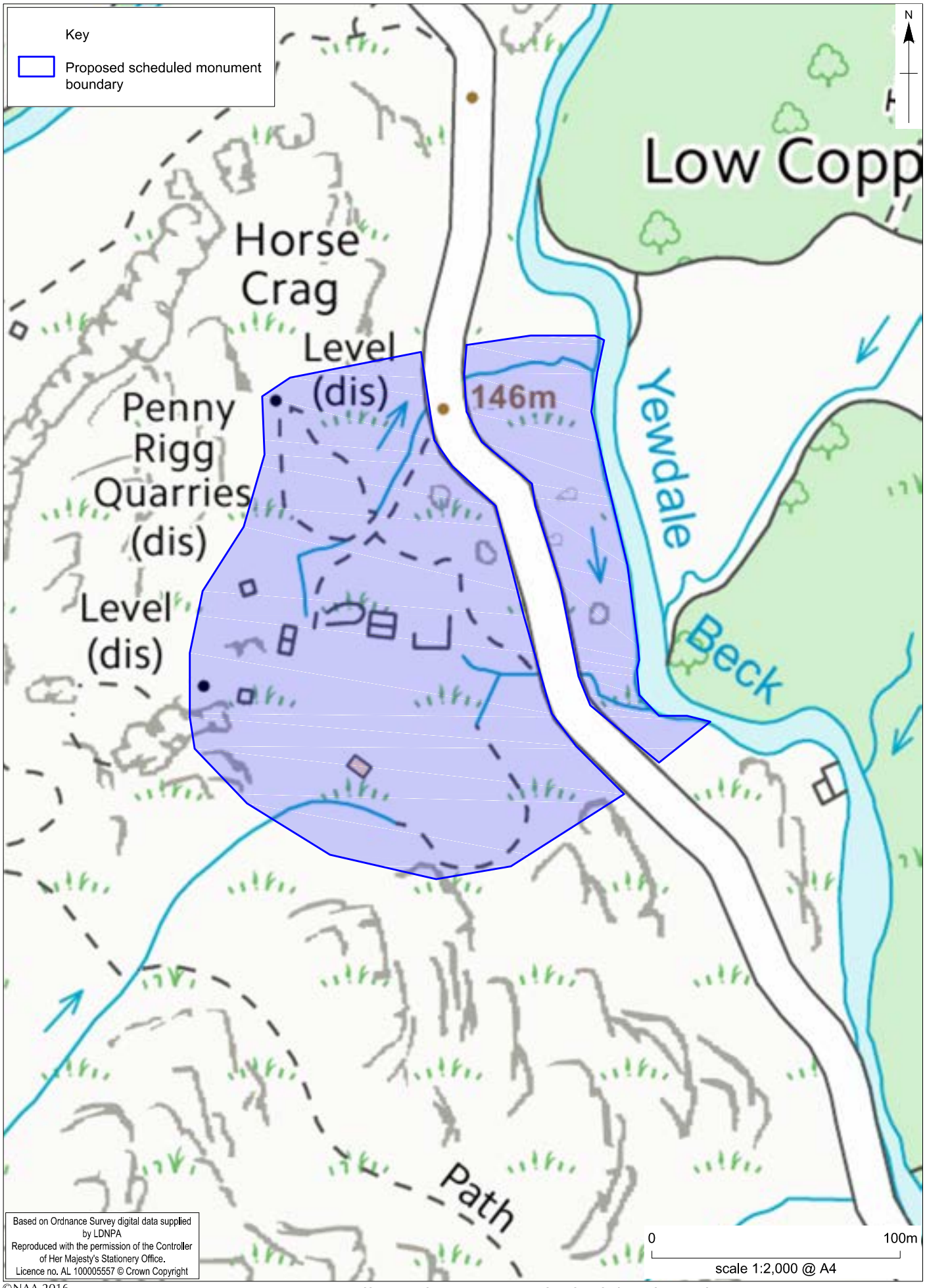
6.9 The ruinous nature of the buildings, coupled with extensive rid tips, networks of streams, and location on the east-facing slope overlooking the Yewdale valley, all contribute to the site's aesthetic value and unique sense of place. The juxtaposition of the decayed structures and verdant re-growth of vegetation evokes a strong emotional response from visitors to the site, further enhanced by changes in the weather and seasons. The site is frequently visited by walkers and the nearby Horse Crag Quarry car park is a popular starting point for day hikes. It is also used by groups – particularly youth groups – for climbing and orienteering in and around the quarry. In addition to the more casual visitor, the mill has considerable communal value for mining enthusiasts and industrial archaeologists. Members of CATMHS have spent a number of years working on clearing Horse Crag Level in an attempt to push through to the old Tilberthwaite workings. Despite, numerous setbacks, the team have been successful in clearing much of the adit – continuing a legacy dating back almost to the foundation of the level 150 years ago.

7.0 RECOMMENDATIONS FOR FURTHER WORK

Scheduling the site

7.1 It is recommended that consideration should be given to scheduling Penny Rigg copper mill in order to protect the exceptional significance of the site for future generations. Potential risks arising that are not directly related to condition include: re-working of the closehead or surface quarries, sale of rid tips for aggregate, fossicking (prospecting), tree planting, development of the riving shed and installation of services, demolition of surface structures, changes in grazing and land management regimes; and the erection of fences.

7.2 A Scheduled Monument is afforded statutory protection under the Ancient Monuments and Archaeological Areas Act 1979. This is the highest level of protection that can be placed on a heritage site and would make it a criminal offence to demolish, destroy, damage, remove, repair, alter, or add to the site unless prior Scheduled Monument Consent was obtained from the Secretary of State for the Department of Culture, Media and Sport.



Penny Rigg copper mill, Cumbria: proposed scheduling boundary *Figure 37*

7.3 The following tables assess the Penny Rigg mine and copper mill according to the scheduling criteria for industrial sites as detailed in *Designation. Scheduling Selection Guide: Industrial Sites* (English Heritage 2013).

Table 1: Summary of significance according to scheduling criteria

Period	Penny Rigg is a rare example of a mid-19th-century copper mill. It is largely a single-phase mechanised mill and is considered to be an exemplar of its type, representing the culmination of advances made in processing methods and technologies over the preceding two centuries of copper mining.
Rarity, representativity and selectivity	There are a number of other dressing mills in the area, most notably at Coniston (Paddy End, Upper and Lower Bonsor), but these are much larger, multi-phase operations. The remains of the mill at nearby Greenburn copper mine, on the north flank of Wetherlam, are more complete than Penny Rigg, but are later in date, evidenced by the complexities of ore recovery techniques used, including acid leaching. Of the mills of a similar date (Roughton Gill, Red Gill and Goldscope), Penny Rigg is the most comprehensive, with few standing structures surviving at the other sites. Other dressing floors and mills in the area – most notably Coniston – were altered and expanded over a number of years and, therefore, represent a number of different phases of development.
Documentation	There are a wide range of primary documents associated with the site from all periods of its use. These can be found in the CATMHS archive at the Armitt Museum and Library and the Whitehaven Record Office (Muncaster Collection) and Kendal Record Office (Rydal Estate Collection). The site has important connections with Barratt and Taylor (although the latter had no direct involvement), and the various innovations they introduced to the region's mining industry.
Group Value	The mill is associated with Tilberthwaite mine, one of the oldest mines in the region. It forms part of a group of Cumbrian mines, which include Coniston, Goldscope, Greenburn, and Carrock End, amongst others. The dressing mill forms part of a smaller sub-group of processing complexes and is one of the best examples of a single-

	phase mechanised site.
Survival	The mill complex is relatively well-preserved, although in urgent need of consolidation. Evidence is preserved at the site of all the various processes associated with ore production, except for smelting. Processes include: mining the ore, ragging, crushing, dressing, settling and tailing, power transmission, water management, and transportation.
Potential	There is the potential to develop a greater understanding of the operation and development of the mill via: further documentary research, archaeological investigation, environmental sampling of tailings pond, and improvements to public access and interpretation.

7.4 It is proposed that the boundary of the scheduled area should be slightly larger than the project area: extended to the north to encompass the quarry level and leat; to the west to include the entrance to Horse Crag Level; and to the east to include the tailing pond(s) (Fig. 37).

7.5 Structures associated with some scheduled mining sites are also often listed under the Planning (Listed Buildings and Conservation Areas) Act 1990. However, given that all of the buildings associated with the mill are in a semi-ruinous state and it is unlikely they will be re-used or re-developed, it is believed that listing would not be appropriate in this instance. In terms of any future planning applications, scheduling will always takes precedence over listing and covers both buried and built archaeology. The preservation of the mill and mine setting would also be a material consideration.

Conservation Works

7.6 A conditions survey on the mill remains has been previously been carried out by Countryside Consultants and a programme of consolidation and stabilisation work is scheduled to commence in 2017.

Archaeological Investigation

7.7 Targeted excavation should be considered in four key areas in order to inform a greater understanding of the layout and operation of the complex:

i. the interior of the crusher house, in order to understand more about the form of the building (particularly on the east side), its layout and operation;

ii. the interior of the dressing mill, in order to understand the arrangement of jigs, etc., and possibly confirm the presence of stamps;
iii. the potential wheel pit to the south of the dressing mill, and
iv. the buddles on the terrace to the east of the settling ponds.

7.8 The investigations detailed above could be undertaken as part of a community training excavation, providing that an appropriate risk assessment, to include risks of contamination, was undertaken in advance and appropriate mitigation measures put in place.

Archaeo-environmental sampling

7.9 A limited programme of auger sampling and archaeo-environmental analysis is recommended of the tailing ponds on the bank of the beck. The aim of this would be to examine the matrix of the soil cores to determine any evidence of the lamination associated with slime ponds, and the make-up of the associated deposits. However, flooding in the area may have had a significant impact on such evidence.

Further documentary research

7.10 The disparate nature of the archive evidence limited the amount of research that could be undertaken in preparation of this report, although members of CATMHS have very kindly made their own personal research available. A more thorough and meticulous review of the archive – particularly the mine account books – would doubtless inform a more comprehensive understanding of the mill's development and operation. Such work could readily be undertaken by CATMHS members or other volunteers with an interest in the site. A workshop on documentary research was provided as part of the current survey project.

Interpretation

7.11 Consideration should be given to improving both on-site and off-site interpretation. Suitably robust notice boards recounting the history of the site and describing the workings of the mill might be appropriate, perhaps along the lines of the series produced recently for the North York Moors National Park Authority for Roseberry Topping Ironstone Mine (with advice from NAA, Plates 55, 56). Care would need to be taken in the location of the boards so as not to detract from the unique setting and sense of place of the mill and surrounding area. The small lay-by at the bottom of track (700) might be an appropriate location.

Plates 55, 56: *interpretation panels installed at Roseberry Topping Ironstone Mine showing the operation of the mine and how it functioned within the wide landscape*

7.12 An industrial walking trail, downloadable from the LDNPA website onto a mobile phone, or as a printable PDF, is worth consideration[6]. CATMHS have already produced several trail leaflets of the Coniston area, which may be used as the basis for this, including one on Tilberthwaite that covers the mine and the mill (I. Matheson *pers. comm.*).

[6] See http://www.northyorkmoors.org.uk/visiting/enjoy-outdoors/walking/our-walks/walking-routes/rosedale-mineral-railway/rosedale-mineral-railway.pdf for an example.

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APPENDIX 1 PENNY RIGG COPPER MILL SITE INVENTORY

Table 1: *significance of surviving archaeological structures and features*

Context No.	Description	Significance	Associated with	Contribution to Significance	Date	Photo
101	Rock-cut portal of mine level known as Horse Crag Level or Tilberthwaite Deep Adit. Rectangular entrance profile, 2m high x 1.7m wide. Driven to dewater Tilberthwaite Mine and intersect the North Vein at depth. All the rock and ore processed at Penny Rigg mill was brought out through this level. Underground access to Tilberthwaite mine recently achieved by CATMHS.	**High** – of considerable evidential and historic value as the only underground connection between Tilberthwaite mine and Penny Rigg mill. Access to underground workings, including 20th-century slate closehead, adds to overall significance.	Entrance cutting (102) Mine drain (103)	High High	*c.* 1850	
102	Horse Crag Level entrance cutting. Rock-cut trench, 5m deep x 3m wide, connecting Horse Crag Level portal with the surface installations of Penny Rigg mill. Retained slate spoil from Horse Crag quarry at NW end.	**High** – as above. Also demonstrates historical and sequential association between copper and slate working.	Level portal (101) Mine drain (103) Compressor pipe (105)	High High High	*c.* 1850	

Context No.	Description	Significance	Associated with	Contribution to Significance	Date	Photo
103	Entrance to stone-slabbed culvert taking water from Horse Crag Level and the entrance cutting (101-102). Drains N to leat (317).	**High** – good evidential and historical value as demonstrates methods of water control and use.	Mine level (101) Entrance cutting (102) Leat (317)	High High High	*c.* 1850	
104	Stone platform, 3m x 0.8m x 0.54m high. Rectangular slab above rough coursed retaining wall. Foundation course incorporates concrete breeze block suggesting recent construction and use.	**High** – good historical and evidential value as possibly one of the latest structures on site, demonstrating ongoing use of the mine and surrounding area into the late 20th century.	Mine level (101) Compressor pipe (105)	High High	Mid to late 20th century	
105	Iron compressor pipe, 64mm (2½in) diameter attached by iron brackets to N wall of Horse Crag Level and N side of the entrance cutting. Runs NE along surface from E end of cutting towards SW corner of smithy (201).	**High** – as above. Also of significance as provides a visual and physical association between the underground and surface workings.	Mine level (101) Entrance cutting (102) Smithy (201)	High High High	Mid to late 20th century	

Context No.	Description	Significance	Associated with	Contribution to Significance	Date	Photo
106	Shallow linear gully, v-shaped profile, running SW-NE on terrace between top of the Horse Crag Level entrance cutting and track (703). No obvious function.	**Moderate/low** – lack of evidence for date and function reduces the significance of this feature. Further research might establish its association with other elements of the site and increase its relative significance.	Track (703)	Low	Unknown	
107	Flat-topped linear spoil tip composed of distinctive orange-brown mineralised rock. Three distinct tip lines at the S end of spoil tip indicate use of end- or side-tipping wagons, probably running on temporary rail tracks. Spoil derived from driving of Horse Crag Level and from initial surface sorting. Overlain to N by later slate spoil tip (811).	**High** – of considerable historical and evidential value as only area of spoil associated with driving of Horse Crag Level and primary separation of rock and ore. Association with slate spoil tips demonstrates chronological and sequential development on site.	Slate tip (811)	High	*c.* 1850	
201 Group	Smithy and office. The smithy to the south and was built first. The office to the north was added later, but how much later is not known. The west back wall (213) of the office butts up against the back wall (205) of the smithy. Both structures were built into the slope of the hillside. The whole area may have been dug out in one go rather than as two separate events.	**High** – good historical and evidential value. The structures demonstrate several phases of use. Its value is also increased by its association with other features within the vicinity such as the Leat (317) which is directed underground in front of the buildings.	Mine Level (101) Entrance cutting (102) Culvert (103) Culvert (316) Leat (317) South wall of smithy (202) Blocked door (203) Valve for compressed air pipe (204) W wall of smithy (205) N wall of smithy (206) E wall of smithy (207)	High High High High High High High High High High High	*c.* 1850	

Context No.	Description	Significance	Associated with	Contribution to Significance	Date	Photo
	The height of the gable end of the office (213) indicates that these were probably both single storey structures The smithy contains evidence to indicate its original use (209-211) and how its use changed through time (203, 204). The central area has been greatly disturbed by a large tree.		E wall of smithy (207) Buttress (208) Hearth (209) Bellows hole (210) Metal pipe (211) W wall of office (212) N wall of office (213) Window (214) E wall of office (215)	High High High High High High High High High		
202	S wall of Smithy. Coursed random rubble. Survives to a maximum height of 1.40m internally towards the back of the building. The height of the wall decreases towards the front. Includes evidence for what is believed to be a blocked doorway (203). The ground level is higher externally.	**High** – good historical and evidential value as demonstrates the changing function and use of the building.	Blocked door (203) W back wall 205)	High High	*c.* 1850	 

Context No.	Description	Significance	Associated with	Contribution to Significance	Date	Photo
203	Blocked door c. 0.9m wide surviving to roughly 5 courses high. Obvious straight joint between the blocking and wall (202). The blocking consists of roughly rectangular blocks, in contrast to the coursed random rubble of wall (202). To the S is the entrance to the stone slabbed culvert (103), taking water from Horse Crag Level and the entrance cutting (101-102). The gap between the wall (202) and the culvert entrance would have been roughly 1.20m. At some point it may have been decided that it would be more convenient to put the entrance in the east wall of the building, which has a large open area in front of it.	**High** – good historical and evidential value as demonstrates the changing function and use of the building and its relationship to the water management features within its vicinity. Thereby demonstrating chronological depth.	Mine Level (101) Entrance cutting (102) Culvert (103) Wall (202) Leat (317)	High High High High High	Undated	
204	Valve for compressed air pipe (105). Located in the SW corner of the room.	**High** – good historical and evidential value as possibly one of the latest structures on site, demonstrating ongoing use of the mine and surrounding area into the late 20th century. Also of significance as provides a visual and physical association between the underground and surface workings. Also demonstrates the changing use of the smithy building.	Mine level (101) Entrance cutting (102) Compressor pipe (105) S wall (202) W back wall (205)	High High High High High	Mid to late 20th century	

Context No.	Description	Significance	Associated with	Contribution to Significance	Date	Photo
205	W back wall of Smithy. Coursed random rubble wall surviving to roughly 2.30m in height internally and 1m externally, as it is built into the side of the hill. At roughly half-metre intervals the random rubble courses are levelled out by using smaller flatter pieces of slate. As well as the valve for the compressed air pipe (204) this wall also contained several other metal objects including iron bars and spikes.	**High** – good historical and evidential value shows a good example of wall building techniques, various styles of which are present across the site.	S wall (202) NoNrth wall (206)	High High	*c* .1850	
206	N wall of Smithy, which also forms the dividing wall between the smithy and the office has been badly damaged in places by the presence of a tree. The back wall of the office (212) butts up against this wall. Survives to a maximum height of 1.9m internally towards the back of the building. The height of the wall decreases towards the hearth. The upper half of the wall consists of coursed random rubble and the lower half contains more even sized rectangular blocks of slate. The NE corner of the smithy, towards the base of the wall contains some large slab like pieces of slate forming quoins. The hearth (209) has been built into the NE corner of the smithy and may have been partially keyed into the	**High** – good historical and evidential value, but badly damaged by the presence of the tree.	W back wall of smithy (205) E front wall (207) Hearth (209) W back wall of office (212)	High High High High	*c.* 1850	

Context No.	Description	Significance	Associated with	Contribution to Significance	Date	Photo
	wall. The damage caused by the tree makes it difficult to see clearly.					
207	E wall of Smithy. Coursed random rubble. This wall is in a very ruinous state. It survives to a maximum height of 1.6m either side of which it tails off towards the ground and the surrounding rubble. Its maximum length is no more than 3.00m. The N end of the wall where it survives for roughly 3 courses contains some large slab like pieces of slate forming quoins. The wall is visibly leaning outwards, which may have been a problem even before it fell into a ruinous state and could explain why the buttress (208) was built in front of it. This wall may have needed more support because of the location of the hearth (209) within the building.	**High** – good historical and evidential value, but badly damaged.	Buttress (208) Hearth (209)	High High	*c.* 1850	 

Context No.	Description	Significance	Associated with	Contribution to Significance	Date	Photo
208	Buttress. Built predominantly of coursed large flat rectangular stones. Both sides taper to the top. The inside tapers to accommodate the outward lean of the E wall (208). Roughly every other course consists of through-stones and it survives to a maximum height of 1.30m at its northern end. The N face survives intact. It is not possible to tell exactly how far the buttress ran across the front of the building as it is in a ruinous state at its S end. It survives to a maximum length of 2.10m.	**High** – good historical and evidential value as demonstrates the adaptation of the building.	E wall (208) Hearth (209)	High High	*c.* 1850	
209	Hearth. This has a large tree growing out of the middle of it which has caused a lot of damage making it difficult to see the hearth's original form. The bellows hole and metal inlet pipe (210, 211) survive at its W end. The hearth is roughly 2.10m by 1.40m and it survives to a maximum height of 1m. The W elevation is roughly keyed into the north wall (206) and is made up of random coursed roughly rectangular blocks.	**High** – good historical and evidential value as demonstrates the function of the building, although badly damaged by the tree. Its form may be better understood once rubble is cleared.	N wall (206) E wall (207) Buttress (208) Bellows hole (210) Metal inlet pipe (211)	High High High High High	*c.* 1850	

Context No.	Description	Significance	Associated with	Contribution to Significance	Date	Photo
210	Bellows hole. Roughly square opening within the western end of the hearth (209) measuring 0.30 by 0.30m at its widest points. The aperture is approximately 0.15m deep.	**High** – good historical and evidential value as contributes to our understanding of how the building functioned.	N wall (206) Hearth (209) Metal inlet pipe (211)	High High High	*c.* 1850	
211	Metal inlet pipe, 0.15m in diameter and made of iron. The pipe extends into the hearth for a distance of approximately 0.60m at which point it meets the trunk of the tree.	**High** – good historical and evidential value as contributes to our understanding of how the building functioned.	Hearth (209) Bellows hole (210)	High High	*c.* 1850	
212	W back wall of office. Coursed random rubble wall surviving to roughly 1.80m in height internally and 0.45m at its highest point externally as it is built into the side of the hill. This wall butts up against the back wall of the smithy (205). It is not keyed in. This therefore suggests that the office was built after the smithy. The exact date is unknown. The way in which this wall has been built is noticeably different to the back wall of the smithy (205).	**High** – good historical and evidential value shows a good example of wall building techniques, various styles of which are present across the site. It shows how the building was extended to create the office	W back wall of smithy (205) N wall of smithy (206) N wall of office (213)	High High High	*c.* 1850	

Context No.	Description	Significance	Associated with	Contribution to Significance	Date	Photo
213	N wall of office, gable end, tapering towards what would have been the apex of the roof. This helps to confirm that the building was a single storey. There is a single window opening (214) and rough dressed quoins at both corners. Coursed random rubble wall surviving to roughly 2.6m at its highest point internally and 1.8m at its highest point externally as it is built into the side of the hill. Building style similar to the west back wall (212). There is a large square block of stone on the W edge of the window where the top of the window may have been and it is suggested that this may have supported a roof beam.	**High** – good historical and evidential value as contributes to our understanding of how the building functioned.	W back wall of office (212) Window (214) E wall (215)	High High High	*c.* 1850	 
214	Window within the N wall (213) of the office, approximately 0.90m wide. The stones forming the windowsill are keyed into the wall. The window is 1.80m above the ground internally and approximately 1m above the ground externally.	**High** – good historical and evidential value as contributes to our understanding of how the building functioned.	N wall (213)	High	*c.* 1850	

Context No.	Description	Significance	Associated with	Contribution to Significance	Date	Photo
215	E wall of office. Coursed random rubble wall surviving to roughly 1.20m high and 2.00m in length. Rough dressed quoins at the corners, which are larger at the base of the wall. Very little survives and there is no clear evidence for where the door may have been. No evidence for the front wall having been keyed into the front of the smithy.	**Medium** – Very little survives and there is no clear evidence for where the door may have been.	North wall (213)	High	*c.* 1850	 
220 Group	Powder house and attached small annex. Single-storey, single-cell square structure with a single door opening and no windows. Constructed of coursed random rubble, with roughly dressed quoins and protruding through-stones. Partially built into the hillside.	**High** – of considerable evidential value because of its association with the mining process, provides a visual association between the underground and surface workings and how it fits in to the overall process and landscape. Also, good example of another type of wall construction.	S wall (221) Door (222) W wall (223) Through-stones (224) N wall (225) E wall (226) Through-stones (227) W wall (228) N wall (229) Track (703)	High High High High High High High High High High	*c.* 1850	

Context No.	Description	Significance	Associated with	Contribution to Significance	Date	Photo
221	S wall of powder house. Coursed random rubble wall with rough dressed quoins at both corners. Mostly survives to full height. Contains one door (222) at the W end of the wall. The wall building style is similar to that observed for the W (back) wall of the smithy (205). At roughly half-metre intervals the random rubble courses are levelled out by using smaller flatter pieces of slate.	**High** – as above.	Door (222) W wall (223) E wall (226)	High High High	*c.* 1850	
222	Door aperture into the powder house. Approximately 0.90m wide. There are two gaps within the wall to the west of the door, which may indicate where the door was hung.	**High** – as above.	S wall (221) W wall (223)	High High	*c.* 1850	
223	W wall of powder house which survives to full height. Rough dressed quoins at both corners. The wall also contains rows of protruding through-stones (224) at three levels.	**High** – as above.	S wall (221) Through-stones (224) North wall (225)	High High High	*c.* 1850	

Context No.	Description	Significance	Associated with	Contribution to Significance	Date	Photo
224	Protruding through-stones. The W wall (223) contains rows of protruding through-stones at three levels. The stones are flat to the wall on the internal elevation, but protrude from the external elevation.	**High** – as above. The protruding through-stones are not seen on any of the other structures on site.	W wall (223)	High	*c.* 1850	
225	N wall of powder house. Coursed random rubble wall with rough dressed quoins at the NE corner. Mostly survives to full height.	**High** – as above.	W wall (223) E wall (226) W wall (228)	High High High	*c.* 1850	
226	East wall of powder house which survives to full height. Coursed random rubble wall with rough dressed quoins at both corners. Some large square slabs have been used on end to make them look bigger from the front than they actually are. The wall also contains rows of protruding through-stones (227) at three levels.	**High** – as above.	S wall (221) N wall (225) Through-stones (227)	High High High	*c.* 1850	

Context No.	Description	Significance	Associated with	Contribution to Significance	Date	Photo
227	Protruding through-stones. The east wall (226) contains rows of protruding through-stones at three levels. The stones are flat to the wall on the internal elevation, but protrude from the external elevation.	**High** – as above. The protruding through-stones are not seen on any of the other structures on site.	E wall (226)	High	*c.* 1850	
228	W wall of small outside annex. The majority of the wall is created by the presence of bedrock. The gap between the bedrock and the N wall (225) of the powder house (220) has been filled with coursed random rubble. Survives to a height of roughly 1.30m. It may not have been much taller than this.	**High** – as above.	N wall (225) N wall (229)	High High	*c.* 1850	

Context No.	Description	Significance	Associated with	Contribution to Significance	Date	Photo
229	N wall of small outside annex. Coursed random rubble wall, surviving to a height of roughly 1m and 1.70m long. This wall was built against bedrock and into the hillside.	**High** – as above.	W wall (228)	High	*c.* 1850	
300 Group	Waterwheel pit or housing. Raised, rectangular structure, constructed for 32 feet (9.75m) wheel which powered crushing machinery in the adjacent building (400). An open leat (317) brought water to a holding pond (310-14) above the wheel pit.	**High** – well preserved and only surviving on-site example of a waterwheel pit. Value increased by its structural, group and visual association with associated features such as water supply system and crusher house which allow interpretation of full process of water-powered ore crushing.	Leat (316-19) Holding pond (310 G) Crusher house (400 G)	High High High	*c.* 1860	

Context No.	Description	Significance	Associated with	Contribution to Significance	Date	Photo
301	S wall of wheel pit (300). Random rubble coursing, incorporating a number of exceptionally large blocks. Rough dressed quoins at SE corner. Overlain to W by crusher house wall (401).	**High** – as above	N wall of crusher house (401)	High	*c.* 1860	
302	N wall of wheel pit (300). Random rubble coursing with rough dressed quoins at NE corner. Terraced into slope at W end. Overlain to W by holding pond wall (312).	**High** – as above	Holding pond E wall (312)	High	*c.* 1860	
303	E or end wall of wheel pit (300). Random rubble coursing with roughly dressed quoins. Outfall opening at base of wall (304).	**High** – as above. Also provides evidence for integrated water control.	Outfall tank (304) Culvert (306) Culvert (424)	High High High	*c.* 1860	

Context No.	Description	Significance	Associated with	Contribution to Significance	Date	Photo
304	Outfall tank for wheel pit (300). Rectangular sub-surface opening with stone lintel at base of wall (303). Connects with two culverts, (306) and (416), leading N and S respectively.	**High** – good evidential value as helps explain the use and control of water supply systems at the site.	Wheel pit (300) Culvert (306) Culvert (416)	High High High	*c.* 1860	
305	Possible activity area or building platform. Rectangular area, 4.60m x 9.60m, partially terraced against slope to W where there are also traces of a low retaining wall. There is an area of crushed mineral spoil in the centre of the platform.	**High** – good historical and evidential value as may provide archaeological evidence for additional structures and/or activities associated with ore treatment. Potential for below ground survival of archaeological features and deposits.	Wheel pit (300)	High		
306	Culvert. Stone-slabbed 'cut-and-cover' drain between outflow opening (304) of waterwheel pit and leat (308). Carried surplus outflow from wheel pit (300).	**High** – good evidential value as helps explain the use and control of the water supply systems at the site.	Waterwheel pit (300) Outflow tank (304)	High High		

Context No.	Description	Significance	Associated with	Contribution to Significance	Date	Photo
307	Culvert opening. Stone-slabbed opening, 0.7m wide x 0.5m high, at N end of culvert (306). Leads into leat (308). Carried surplus outflow from wheel pit (300).	**High –** as above	Wheel pit (300) Culvert (306) Leat (308)	High High High	*c.* 1860	
308	Leat. Open leat, cut into natural slope to W with linear upcast bank to E. Low stone wall along E side of leat. Carried surplus outflow from wheelpit (300). Obscured to N by line of track (705).	**High** – as above. Association with track (705) helps establish sequence of use and abandonment between features on site and provides additional sequential and chronological evidence.	Culvert (306-07) Track (705)	High High	*c.* 1860	
309	Leat. N continuation of leat (308). Survives as a V-profile linear gully with upcast mound to E. Disturbed to S by track (705) and to N by track (700). Would have continued N of track (700) but route cannot be identified. Carried surplus outflow from wheel pit (300).	**High** – as above. In addition, Association with track (700) increases chronological and historical significance.	Track (700) Track (705)	High High	*c.* 1860	

Context No.	Description	Significance	Associated with	Contribution to Significance	Date	Photo
310 Group	Holding pond for wheel pit (300). Rectangular stone walled structure built against the slope to the W and butting against and raised above wheel pit (300) to E.	**High** – considerable evidential significance as fundamental to understanding and interpretation of use and control of water supply on site. Also important group value in relation to waterwheel pit and crusher house.	Leat (316-19) Wheel pit (300) Crusher house (400)	High High High		
311	Wall of coursed random rubble retaining the N side of the holding pond. Constructed against the natural slope, the battered wall rises in height to the E reaching a maximum height of 2.5m. The E end curves inwards.	**High** – as above	Holding pond (310)	High	*c.* 1860	
312	Battered wall of coursed random rubble retaining the E end side of the holding pond. Constructed above wheel pit (300) and overlain to S by crushing house wall (401).	**High** – as above. Also significant in demonstrating relative construction phases with the wheel pit and crusher house.	Wheel pit (300) Holding pond (310) S wall crusher house (401)	High High High	*c.* 1860	

Context No.	Description	Significance	Associated with	Contribution to Significance	Date	Photo
313	Wall of coursed random rubble retaining the S side of the holding pond. Constructed against the natural slope, the battered wall rises in height to the E where it curves inwards to join with end wall (312).	**High** – as (311) above.	Holding pond (310)	High	*c.* 1860	
314	Short retaining wall forming SW end of holding pond (300). Random rubble and boulder construction it keys with and forms W continuation of wall (313).	**High** – as above.	Holding pond (310)	High	*c.* 1860	
315	Turf covered linear channel, slightly oval in plan, within raised platform supported by walls (311-314), Forms the outline of the holding pond. E end disturbed.	**High** – as above.	Holding pond (310)	High	*c.* 1860	

Context No.	Description	Significance	Associated with	Contribution to Significance	Date	Photo
316	Culvert entrance. Stone-slabbed, 0.65m wide X 0.4m high. N end of culvert (103) channelling water from Horse Crag Level (101) into leat (317).	**High** – of high evidential value in demonstrating the use and control of water on site.	Mine drain (103) Leat (317-319) Holding pond (310)	High High High	*c.* 1860	
317	Leat. Cut into slope to W with upcast bank to E; bank and E side of leat retained by discontinuous stone wall. Originally carried water to wheel pit holding pond (310) but association with (310) has been disturbed/destroyed by construction of track (700). The S end recently re-engineered by CATMHS to take water draining N from Horse Crag Level to leat outflow (318).	**High** – as above.	Leat (316, 318-319)	High	*c.* 1860	

Context No.	Description	Significance	Associated with	Contribution to Significance	Date	Photo
318	Outflow to leat (317). Opening, 1.5m wide x 2.7m long, on E side of leat (317). Coursed stone wall survives to N but S side destroyed. Contains remains of timber box culvert. Overflow water runs E down slope to join Yewdale Beck.	**High** – as above.	Leat (317)	High	*c.* 1860	
319	Culvert entrance. Stone-slabbed culvert, 0.5m wide x 0.3m wide, forming N end of leat (317). Overlain by spoil from slate tip (814).	**High** – as above. Also significant in demonstrating chronological relationship between copper mill and slate quarry features and thereby adding chronological depth.	Leat (317) Slate tip (814)	High High	*c.* 1860 or possibly contemporary with tip (814).	

Context No.	Description	Significance	Associated with	Contribution to Significance	Date	Photo
320	Iron bolts on wall head of wheel pit (300). Four bolts survive on top of wall (301) and one on wall (302). Originally held horizontal timber members supporting the waterwheel axle. Bolts are 50mm (2in) diameter with screw thread and nut at top and square iron plate at base.	**High** – considerable evidential and interpretive value in demonstrating constructional and operational aspects of the wheel pit and waterwheel and their association with the crusher house.	Wheel pit (300) Crusher house (400)	High	*c.* 1860	
400 Group	Crusher house. Rectangular structure abutting wheel pit (300) with open front to E and gabled wall to N. Contained roller crusher and stamps for ore breaking .	**High** – considerable historic and evidential value because of the condition and extent of the surviving remains and the potential for interpreting and understanding the operation of water-powered ore crushing. Significant group value in association with the leat system, wheel pit and holding pond. Few crusher houses survive elsewhere in this state of preservation so of regional and national importance.	Leat (317) Holding pond (310) Wheel pit (300)	High High High	*c.* 1860	
401	E wall of crusher house, coursed random rubble, constructed against slope to W. Ties in with wall (406) to S and overlies waterwheel pit wall (301) and N end of holding pond (312).	**High** – joist holes and timber slots within wall provide important evidence for understanding of internal timber elements and the position of associated crusher machinery.	Joist/timber slots (402-405) Wall (406) Wall (301) Wall (312)	High High High High	*c.* 1860	

Context No.	Description	Significance	Associated with	Contribution to Significance	Date	Photo
402	Joist holes in E wall of crusher house (401). Line of five joist holes; central three damaged but joist holes at S and N ends retain rectangular profile. Held timber joists supporting high level or mezzanine floor, S line of which is marked by a recess (407) on adjoining wall (406); material for crushing was brought to this floor through opening (408) in wall (406) for delivery to the crushing rollers housed below.	**High** – as above.	Wall (401) Joist/timber slots (403-405) Recess (407)	High High High	*c.* 1860	
403	Two joist or timber holes set vertically one above the other at N end of wall (401). Function unknown but may have been associated with timber supports for the crushing rollers.	**High** – as above.	Wall (401) Joist/timber slots (402, 404-405)	High High	*c.* 1860	
404	Two timber slots at S end of wall (401). Function unknown but may have been associated with timber structure associated with crushing rollers.	**High** – as above.	Wall (401) Joist/timber slots (402-403, 405)	High High	*c.* 1860	

Context No.	Description	Significance	Associated with	Contribution to Significance	Date	Photo
405	Small rectangular ground level opening at N end of wall (401) and incorporating part of waterwheel pit wall (301). May have held structural timber associated with the crushing rollers or, alternatively, served as a weep-hole allowing drainage from the slope to the W.	**High** – as above.	Wall (401) Joist/timber slots (402-04) Wall (301)	High High High	*c.* 1860	
406	Two iron rods, possibly re-used drill rods or jumpers, set in ground in front of base course of wall (401).	**Medium** – of uncertain function but deliberate association with crusher house wall adds to the group value of the structure.	E wall crusher house (401)	Medium	*c.* 1860	

Context No.	Description	Significance	Associated with	Contribution to Significance	Date	Photo
407	The S wall of the crusher house, coursed random rubble construction with good use of through-stones at free standing E end. Gabled top, offset to the E, with a rectangular opening (410) below and a high-level opening (409) to the W. Joins with wall (401). Retaining walls and inclined tracks (414, 416, 417, 418) butt against the outer or S face.	**High** – openings, joist holes and timber slots within wall provide important evidence for understanding of internal timber elements and the position of associated crusher machinery.	Crusher house (400) Retaining walls and inclined tracks (414, 416-418)	High High	*c.* 1860	
408	Recess to carry high level or mezzanine floor associated with joist holes (402) in adjacent wall (401).	**High** – as above	Crusher house (400) Wall (407)	High High	*c.* 1860	

Context No.	Description	Significance	Associated with	Contribution to Significance	Date	Photo
409	High level opening to W of gable in wall (407). Material from inclined track (416) was carried through this opening onto the floor above the roller crushers.	**High** – of considerable evidential value because of its association with the movement of ore into the building and its potential to interpret processes within the crusher house.	Crusher house (400) Wall (407) Track (416)	High High High	*c.* 1860	
410	Rectangular opening or doorway in wall (407); infilled at base by wall (413). Opening associated with inclined track (414). Possibly used for delivery of ore bearing rock for secondary crushing.	**High** – as above	Crusher house (400G) Wall (407) Track (414)	High High High	*c.* 1860	

Context No.	Description	Significance	Associated with	Contribution to Significance	Date	Photo
411	Two joist holes on internal face of wall (407) to E of opening (410). Possibly associated with timber framework or structure on the E face of the crusher house.	**High** –joist holes and timber slots within wall provide important evidence for understanding of internal timber elements and the position of associated crusher machinery.	Crusher house (400) Wall (407)	High High	*c.* 1860	
412	Two eaves-level joist holes on the gable of wall (407); both gable holes extend through the width of the wall. Probably to support timber tie-beams for the crusher house's roof structure.	**High** – as above	Crusher house (400 G) Wall (407)	High High	*c.* 1860	

Context No.	Description	Significance	Associated with	Contribution to Significance	Date	Photo
413	Low dry stone wall built across and infilling the lower part of opening (410). Presumably, a secondary or later feature added after inclined ramp (414) had gone out of use.	**Medium** – of evidential and chronological value because it relates to a later use/adaption of the structure and thereby demonstrates chronological depth.	Crusher house (400) Wall (407) Opening (410)	High High Medium	undated	
414	Inclined ramp or track above retaining wall (415) and leading to opening (410) in S face of wall (407). Surface covered in broken mineral. S end obscured by slate tips (813) but may originally have been associated with ore hoppers on terrace below.	**High** – of considerable evidential value because of its association with the movement of ore into the building and its potential to interpret processes within the crusher house.	Crusher house (400) Wall (407) Opening (410) Wall (415)	High High High High	*c.* 1860	
415	Random rubble retaining wall below ramp (414). Abutts wall (407) and to S overlain by slate tip (813). Opening of culvert (420) at base of wall.	**High** – of considerable evidential because of its role as important structural element within the site as a whole.	Crusher house (400) Track (414) Culvert (420)	High High High	*c.* 1860	

Context No.	Description	Significance	Associated with	Contribution to Significance	Date	Photo
416	Inclined ramp above retaining wall (417-418) leading to opening (409) in crusher house building. Large edging slabs on E side. Probably designed as a track to take material to top floor of crusher house. S part of ramp overlain by slate tip (813). W section of ramp defined by bedrock outcrop with shot-holes.	**High** – of considerable evidential value because of its association with the movement of ore into the building and its potential to interpret processes within the crusher house.	Crusher house (400) Wall (407) Opening (409) Retaining walls (417-418)	High High High High	*c.* 1860	
417	Dry stone retaining wall between ramps (414) and (416). N end butts against retaining wall (418).	**High** – of considerable evidential because of its role as important structural element within the site as a whole.	Crusher house (400) Wall (407) Ramp (414) Ramp (416) Wall (418)	High High High High High	*c.* 1860	
418	Short length of dry stone retaining wall between N end of wall (417) and crusher house wall (407). Probably designed to allow widening of ramp (416) above.	**High** – of considerable evidential because of its role as important structural element within the site as a whole. Also demonstrates structural detail.	Crusher house (400 G) Wall (407) Wall (417) Ramp (416)	High High High High	*c.* 1860	

Context No.	Description	Significance	Associated with	Contribution to Significance	Date	Photo
419	Short length of retaining wall above ramp (416). Its continuation to the SW is obscured by slate tip (813). Above the wall is an oval area of crushed mineralised rock, 1.9m x 2.3m.	**High** – of considerable evidential because of its role as important structural element within the site as a whole. It may also be one of the few surviving features relating to primary ore breaking and selection.	Ramp (416) Tip (813)	High High	*c.*1860	
420	Entrance to culvert, 0.9m wide x 0.4m high, at base of retaining wall (415). Massive lintel supported by packed stone side walls. Probably constructed to drain the terrace above, it may have culverted a pre-existing stream.	**High** – of high evidential evidence as one of the few surviving features on site relating to the control of natural drainage.	Wall (415)	High	*c.* 1860	
421	Pack wall. A short length of dry stone retaining wall, possibly forming part of a channel associated with drainage from culvert (420). Surrounding area obscured by spoil and recent storm damage.	**High** – of considerable evidential because of its role as important structural element within the site as a whole.	Entrance to culvert (420)	High	*c.* 1860	

Context No.	Description	Significance	Associated with	Contribution to Significance	Date	Photo
422	Wrought iron bar, 1.62m long x (1 ½ inch) diameter set in rubble/spoil. At one end is a (9 inches) long hand forged bolt attached to a 0.10m x 0.10m (4in x 4in) iron plate. The bar presumably held or supported a timber element and may have formed part of a larger timber structure.	**High** – considerable evidential value as one of the few surviving pieces on site of structural metalwork. Potential for further research and interpretation.	Possibly crusher house (400)	High	*c.* 1860	
423	Paved area composed of large rectangular stone slabs. Obscured to W and S by slate spoil tip (813). Function unknown but may be the interior of a timber sided structure; alternatively a slabbed surface for some form of ore breaking.	**High** – considerable evidential value as may provide archaeological evidence for additional structures and/or activities associated with ore treatment. Potential survival of archaeological features and deposits.			*c.* 1860	
424	Culvert opening. S opening of culvert between wheel pit (300) and tank (425). Slab roof construction supporting N wall of (425).	**High** – of high evidential value in demonstrating the use and control of water on site.	Outflow tank (304) Tank/holding pond (425)	High High	*c.* 1860	

Context No.	Description	Significance	Associated with	Contribution to Significance	Date	Photo
425	Rectangular , sunken stone walled tank associated with culverts (424) and (426). The W wall has been partly destroyed. The tank may have served as a small holding pond for a waterwheel powering machinery within dressing mill (500).	**High** – as above	Culvert (424)	High	*c.* 1860	
426	Short length of stone roofed culvert at SE corner of tank (425). Led water to external face of dressing mill wall (507).	**High** – of high evidential value in demonstrating the use and control of water on site.	Tank/holding pond (425) Wall (507)	High High	*c.* 1860	
427	Length of dry stone retaining wall joining with wall (428) to N. S extent obscured by slate tip (831). Forms E edge of slabbed-floor area (423).	**High** – of considerable evidential value because of its role as an important structural element within the site as a whole.	Wall (428) Floor (423)	High High	*c.* 1860	

Context No.	Description	Significance	Associated with	Contribution to Significance	Date	Photo
428	Semi-collapsed length of dry stone retaining wall joined to W with wall (427)	**High** – as above.	Wall (427)	High	*c.* 1860	
429	Length of low retaining wall E of tank (425). Continuation to N disturbed by possible landslip. May be a single feature with wall (431).	**High** – good evidential value for the construction and use of terraced features as part of the integrated design of the site.	Wall (431)?	High	*c.* 1860	
430	Dry stone retaining wall in front and E of wheel pit (300). May be associated with construction and structural support of culverts (306) and (424). Alternatively, it may have been constructed after failure of retaining wall (429/431).	**High** – good evidential value because of its role as an important structural element of the site as a whole.	Culvert (306)? Culvert (424)?	High High	*c.* 1860	

Context No.	Description	Significance	Associated with	Contribution to Significance	Date	Photo
431	Low stone retaining wall built against slope to W. Terrace above used by access track (432).	**High** – good evidential value for the construction and use of terraced features as part of the integrated design of the site.	Track (432)	High	*c.* 1860	
432	Probable access track to crusher house (400 G). Follows partly artificial terrace above and parallel to retaining wall (431).	**High** – as above.	Wall (431)	High	*c.* 1860	
500 Group	Building and related structures associated with ore dressing and processing. Incudes a probable mill building (501-515) and an area of settling ponds (516-522). The mill, open sided to the E, probably housed a set of jigs powered by a waterwheel located against the external S wall. The settling ponds were not enclosed.	**High** – considerable historical and evidential value as a well preserved and regionally/nationally important copper dressing mill with associated settling ponds. Good potential for survival of archaeological features associated with ore dressing machinery such as jigs.	Mill features (501-515) Settling pond features (516-522)	High High	*c.* 1860	

Context No.	Description	Significance	Associated with	Contribution to Significance	Date	Photo
501	Coursed random rubble retaining wall forming the W side of the mill building. Built against the natural slope, it incorporates two ore chutes or hoppers (504-05).	**High** – good evidential value as part of structural layout of dressing mill.	Mill (500) Ore hoppers (504-505) Launder support (503)?	High High High	*c.* 1860	
502	Buttress built against N end of mill wall (501). Feature (503) is incorporated within the buttress. Both the buttress and wall (501) have been destroyed to the N.	**High** – good evidential value as part of structural layout of dressing mill.	Mill (500) Wall (501) Launder support (503)?	High High High	*c.* 1860	

Context No.	Description	Significance	Associated with	Contribution to Significance	Date	Photo
503	Shallow stone rubble plinth at the base of wall (501) and associated with opening (506) in wall (507) and the opening at the base of buttress (502). Function unknown, but may have supported a wooden launder supplying water to the mill.	**High** – good evidential value as demonstrates use and control of water supply within the mill. Further research needed, but potential to aid interpretation of ore dressing process.	Mill (500) Launder support (503)? Buttress (502) Wall (501) Wall (507) Opening (506)	High High High High High High	*c.* 1860	
504	High-level rectangular opening with angled base/sill in S section of wall (501). Probable ore chute taking crushed material to the jigs.	**High** – good evidential value as one of only two ore hoppers on site and demonstrates process for delivering material between the crusher house and the mill.	Mill (500) Wall (501)	High High	*c.* 1860	

Context No.	Description	Significance	Associated with	Contribution to Significance	Date	Photo
505	High-level rectangular opening with angled base/sill in N section of wall (501). Probable ore chute taking crushed material to the jigs.	**High** – as above.	Mill (500) Wall (501)	High High	*c.* 1860	
506	Rectangular opening in the SW corner of mill wall (507). Associated with feature (503).	**High** – good evidential value as demonstrates use and control of water supply within the mill. Further research needed but potential to aid interpretation of ore dressing process.	Mill (500) Wall (507) Plinth (503)	High High High	*c.* 1860	
507	S wall of mill building. Coursed random rubble construction with rectangular opening (510) towards W section of wall. The profile of the wall shows a double roof line with a gable apex above opening (510) and a valley feature to the E. The E end of the wall is absent but there is a vertical face suggesting an E door or window; a later wall (515) butts against the E end of (507). At the E end wall (507) sits above a wider foundation or settling course (509).	**High** – good evidential value as part of structural layout of dressing mill. Also provides unique information on the constructional form and detail of the mill roof.	Mill (500) Wall (509) Wall (515) Opening (510)	High High High High	*c.* 1860	

Context No.	Description	Significance	Associated with	Contribution to Significance	Date	Photo
508	Stone retaining wall, 1.7m high, within the main mill building. To the S it is abutted by wall (509) and overlain by mill wall (507). To the N the wall buts against settling pond retaining wall (516).	**High** – good evidential value for the construction and use of terraced features as part of the integrated design of the site.	Wall (507) Wall (509) Wall (516)	High High High	*c.* 1860	
509	Foundation course for mill wall (507). Wall (515) has been constructed against its E end.	**High** – good evidential value as demonstrates structural detail of wall construction and chronological association with adjacent walls.	Wall (507) Wall (515)	High High	*c.* 1860	
510	Rectangular opening, 0.9m wide by 1.46m high, in mill wall (507). Stone and timber lintels. The dimensions of the opening suggest a doorway but it may have been used to take drive equipment powered by a putative waterwheel housed against the external wall of (507).	**High** – good evidential value through association with putative second waterwheel and the operation of machinery within the mill building. Further research may aid understanding and interpretation.	Mill (500) Wall (507)	High High	*c.* 1860	

Context No.	Description	Significance	Associated with	Contribution to Significance	Date	Photo
511	Collapsed wall, approx. 0.55m wide, constructed from randomly coursed slate rubble. Runs parallel to wall (512) and the two may have formed the outer sides of a single rectangular structure.	**High** – good evidential value as demonstrates a second phase of construction within the mill complex.	Mill (500) Wall (512) Wall (515)	High High High	Second phase construction – post-1860	
512	Collapsed wall, approx. 0.6m wide, constructed from randomly coursed slate rubble. Runs parallel to wall (511) and the two may have formed the outer sides of a single rectangular structure. To the S butts against and may be contemporary with wall (515).	**High** – as above.	Mill (500) Wall (511) Wall (515)	High High High	Second phase construction – post-1860	
513	Retaining wall, 1.7m high, forming the E side of the mill building. Collapsed towards S end and to N abuts buttress (514). Overlain to S by wall (511)	**High** – good evidential value for the construction and use of terraced features as part of the integrated design of the site.	Mill (500) Wall (511) Wall (512) Wall (514) Wall (515)	High High High High High	*c.* 1860	

Context No.	Description	Significance	Associated with	Contribution to Significance	Date	Photo
514	Rubble buttress forming a short continuation of retaining wall (513).	**High** – good evidential value for the construction and use of terraced features as part of the integrated design of the site.	Mill (500) Wall (513)	High High	*c.* 1860	
515	Poorly constructed slate rubble wall, partly collapsed. May form S end of structure with walls (511) and (512). Butts against E end of mill wall (507) and may infill possible door feature in that wall.	**High** – good evidential value as demonstrates a second phase of construction within the mill complex.	Mill (500) Wall(511) Wall(512) Wall (513)	High High High High	Second phase construction – post-1860	

Context No.	Description	Significance	Associated with	Contribution to Significance	Date	Photo
516	Stone-faced bank, forming E edge of settling pond (521). Inner or W face is 0.4m high incorporates angled slabs. The outer face forms a 0.95m high retaining wall and is parallel to access track/terrace (538).	**High** – good evidential value as forms an integral part of the settling pond structure. The ponds are in good condition, form an important group association with the mill building to the S. Good condition and relative rarity suggests regional and possibly national significance.	Settling pond (517-522) Track (538)	High High	*c.* 1860	
517	Stone-faced bank, 1.2m wide x 0.75m high, forming E edge of settling pond (520). Drain feature (522) at N end. S end obscured by tumbled masonry/landslip.	**High** – as above	Settling pond (516), (518-522)	High	*c.* 1860	

Context No.	Description	Significance	Associated with	Contribution to Significance	Date	Photo
518	Retaining wall built against slope and forming the W wall of the settling tank area. Joins with wall (519) to the N. Collapsed to S.	**High** – as above	Settling pond (516-517, 519-522)	High	*c.* 1860	
519	Retaining wall built against slope and forming the N edge of settling tank (520). Profile of the wall follows the slope profile.	**High** – as above	Settling pond (516-518, 520-522)	High	*c.* 1860	
520	Rectangular settling pond. Defined to W and N by walls (518) and (519) and separated from pond (521) by bank (517). Obscured to S by collapsed material.	**High** – as above	Settling pond (516-519, 521-522)	High	*c.* 1860	

Context No.	Description	Significance	Associated with	Contribution to Significance	Date	Photo
521	Rectangular settling pond. Defined to W and E by walls (517) and (516). Pond (521) is slightly lower than pond (520).	**High** – as above	Settling pond (516-520, 521)	High	*c.* 1860	
522	Channel, 0.6 m wide, between settling ponds (520) and (521). Probably operated by a simple paddle sluice the channel allowed water and sands to drain from pond (520) to pond (521).	**High** – as above	Settling pond (516-521)	High	*c.* 1860	
523	Support wall for top of steps (524). Built over culvert (426) and incorporating the external corners of mill walls (503) and (507).	**High** – good evidential value as forms an integral part of the mill complex.	Culvert (426) Mill (500) Steps (524) Wall (525) Wall (503) Wall (507)	High High High High High High	*c.* 1860	

Context No.	Description	Significance	Associated with	Contribution to Significance	Date	Photo
524	Angled flight of stone steps accessing the area immediately S of mill wall (507). Built against wall (523) and defined to the S by wall (525).	**High** – as above.	Mill (500) Wall (523) Wall (525)	High High High	*c.* 1860	
525	Wall line surviving as tumbled foundation course. Forms E edge of a rectangular space or structure defined to the N by mill wall (507) and accessed to the SW by steps (524). Possible location for waterwheel powering the mill machinery.	**High** – as above. Also of potential significance as location of putative second waterwheel; further research required.	Mill (500) Wall (524)	High High	*c.* 1860	
526	Culvert. Exit for stone-slabbed drain associated with culvert (426) to the W. May have served as the outflow channel for a putative waterwheel housed between mill wall (507) and wall (525).	**High** – good evidential value as forms an integral part of the mill complex and also of importance in understanding water control and use at the site.	Mill (500)	High	*c.* 1860	

Context No.	Description	Significance	Associated with	Contribution to Significance	Date	Photo
527	Retaining wall built against slope to W. Random water rolled boulder construction on boulder plinth. Collapsed to N. On same line as retaining wall (513).	**High** – good evidential value because of its role as an important structural element of the site as a whole.	Mill (500)	High	*c.* 1860	
528	Rectangular buddle, 1.6m x 2.9m, retained to E by wall (529). Forms a group with buddles (530), (531).	**High** – good evidential value as one of only three buddles at the site and because of the information it provides on the relative level of technology in use.	Wall (529) Buddle (530) Buddle (531)	High High High	*c.* 1860	
529	Curved retaining wall, 1.6m high, to E of buddle (528). Battered rubble face on boulder plinth.	**High** – good evidential value because of structural association with a buddle.	Buddle (528)	High	*c.* 1860	

Context No.	Description	Significance	Associated with	Contribution to Significance	Date	Photo
530	Rectangular buddle, 1.4m x 3.2m, with subsurface drain at E end. Forms a group with buddles 528 and (531). Buddle waste and sand exposed in stream cut to S.	**High** – good evidential value as one of only three buddles at the site and because of the information it provides on the relative level of technology in use.	Buddle (528) Buddle (531)	High High	*c.* 1860	
531	Rectangular buddle, 1.1m x 3.3m. Forms a group with buddles (528) and (530).	**High** – as above.	Buddle (528) Buddle (530)	High High	*c.* 1860	
532	Low retaining wall, boulder construction, built against slope to W. Possibly constructed to retain the ground surrounding buddles (530) and (531).	**High** – of good evidential value because of its role as a structural element associated with two of the three buddles.	Buddle (530) Buddle (531)	High High	*c.* 1860	

Context No.	Description	Significance	Associated with	Contribution to Significance	Date	Photo
533	Short length of low retaining wall. Possibly associated with buddle (530).	**Medium** – of value as a structural element of the site but importance lessened because of function unknown.	Budldle (530)	Medium	*c.* 1860	
534	Culvert and drain. Short section of culvert with slabbed roof, partly destroyed by stream action. Probably associated with drainage from mill and the putative second waterwheel. Continues as drain (535).	**Medium** – of value in providing information on water control but significance lessened because of damaged state.	Culvert (535)	Medium	*c.* 1860	
535	Truncated section of drain/culvert. Survives to W as channel. A continuation of culvert (534).	**Medium** – as above.	Culvert (534)	Moderate	*c.* 1860	

Context No.	Description	Significance	Associated with	Contribution to Significance	Date	Photo
536	Culvert. Section of well-constructed boulder wall and slab roof culvert under mine track (705). Continues S to modern road as open, stone walled channel. A continuation of culvert/watercourse (535).	**High** – of good evidential value, despite its truncated state, because of association with track and fine structural condition.	Track (705) Culvert (535)	High High	*c.* 1860	
537	L-shaped depression between N end of wall (516) and mine track (705). Possibly associated with drainage between settling pond (521) and buddles (528), (530) and (531).	**Medium** – current level of significance relates to uncertainty over function. Future research may establish an association with the other mill features.	Settling pond (521)? Buddle (528)? Buddle (530)? Buddle (531)?	High High High High	*c.* 1860	
538	Possible access track to SE corner of mill complex. On natural (?) terrace parallel to retaining wall (516).	**High** – good evidential value for the construction and use of terraced features as part of the integrated design of the site.	Wall (516)	Medium	*c.* 1860	

Context No.	Description	Significance	Associated with	Contribution to Significance	Date	Photo
539	Mine tips with distinctive orange-brown colour of copper mineralisation. Top of tips at same height as crusher house (400) suggesting the tips are waste from crushing process. Probably connected to crusher house by tramway or barrow run but this area now covered by waste from slate spoil tip (813).	**High** – good evidential and spatial evidence for dumping of secondary waste material. The only surviving example on the site of spoil from the crusher house. Provides interesting chronological and visual contrast with overlying slate tips. Distinctive colour is of aesthetic significance.	Crusher (400) Slate tip (813)	High High	*c.* 1860	
600	One or possibly two slime or tailings ponds below modern road and W side of Yewdale Bank. Defined by a series of banks enclosing an area with fine, laminated sands typical of mine tailings. S section badly damaged by recent floods.	**High** – good example of closely dated and well preserved tailings ponds with distinctive banked divisions and early use of levée-like safety banks to prevent discharge of waste into beck. Of regional significance.	Associated pond features (601-607)	High	*c.* 1860	

Context No.	Description	Significance	Associated with	Contribution to Significance	Date	Photo
601	Large beck side bank, 2.75m wide x 0.95m high. Turf and earth core with single stone face to W and discontinuous double stone face to E. To S terminates at natural outcrop with possible overflow channel (606) beyond.	**High** – good evidential value as forms an integral part of the tailings ponds feature group.	Associated pond features (602-607)	High	*c.* 1860	
602	Low, discontinuous retaining wall against SW bank and forming curved S section of tailings pond.	**High** – as above	Associated pond features (601, 603-607)	High	*c.* 1860	

Context No.	Description	Significance	Associated with	Contribution to Significance	Date	Photo
603	Low retaining wall below (E) modern road. Forms SW perimeter of tailings pond.	**High** – as above	Associated pond features (601-602, 604-607)	High	*c.* 1860	
604	Stone faced bank running W from beck side bank (601) to base of slope. Gap or sluice (607) at E end	**High** – as above	Associated pond features (601-3, 606-07)	High	*c.* 1860	
605	Area N of bank (604) and defined to E by beck side bank (601). Possibly a secondary tailings pond taking accidental discharge of waste from N section of mill complex.	**High** – as above	Associated pond features (601-604, 606-07)	High	*c.* 1860	

Context No.	Description	Significance	Associated with	Contribution to Significance	Date	Photo
606	Channel, 1.4m wide, at S end of bank (601). Probable overflow channel allowing water but not tailings to enter Yewdale Beck.	**High** – as above	Associated pond features (601-605, 607)	High	*c.* 1860	
607	Gap at E end of bank (604), possible sluice or overflow between main tailings pond and putative pond (605).	**High** – as above	Associated pond features (601-606)	High	*c.* 1860	
700	Track between modern road and Horse Crag quarry. Shown on Third Edition Ordnance Survey map of 1915, but not earlier editions. Cuts across route of track (705).	**High** – of good evidential value because of chronological and cartographical relationship to other tracks on site.	Track (705) Leat (309)	High High	Post 1898	

Context No.	Description	Significance	Associated with	Contribution to Significance	Date	Photo
701	Original track to mine and quarry from the NW. Constructed against NW slope and partly revetted to SE. Survives as terraced trackway between modern road and track (700) but overlain in central section by slate tip (814). Shown on First Edition Ordnance Survey map of 1850.	**High** – as above. Also of significance because of chronological and functional association with later slate tip.	Culvert (702) Spoil tip (814)	High High	Before 1850	
702	Culvert, stone slab roof and stone sides carrying outflow water from leat (317) under track (701). Probably contemporary with (701).	**High** – good evidential value as relates to use and control of water and its functional association with the track system.	Leat overflow (318) Track (701)	High High	Before 1850	
703	Track constructed against W slope with discontinuous stone revetment to E. Runs between smithy (201) and slate riving shed (800). Not shown on First Edition Ordnance Survey map.	**High** – of good evidential value because of chronological and cartographical relationship to other tracks on site. Also of significance because of chronological association with later slate workings.	Slate tip (814) Riving shed (800)	High High	Post 1850.	

Context No.	Description	Significance	Associated with	Contribution to Significance	Date	Photo
704	Inclined track from Horse Crag quarry on NE side of slate spoil tip (811).	**High** – of good evidential value because of chronological and cartographical relationship to other tracks on site. Also of significance because of direct association with post-copper mill slate quarrying.	Tip (811)	High	Late 19th century	
705	Track running NW from the modern road to the mine. Incorporates culvert (536), cuts leats (308) and (309) and is overlain by track (700). Not shown on First Edition Ordnance Survey map. Probably became the main access route for the mine and mill but may have continued in use when he site was re-worked for slate in the later 19th century.	**High** – of good evidential value because of chronological and cartographical relationship to other tracks on site.	Leat (308) Leat (309) Culvert (536) Track (700)	High High High High	Probably *c.* 1860	
706	A 20m length of trackway, 1.4m wide, terraced into slope to W and truncated by track (700) and the modern road. Probably a section of the original dale road.	**Medium-low** – some evidential value as relates to part of pre-tarmac road along alley. Not directly relevant to history and archaeology of Penny Rigg mill.	Track (700)	High	Mid-19th century or earlier	

Context No.	Description	Significance	Associated with	Contribution to Significance	Date	Photo
800 Group	Riving Shed associated with nearby level opening. Appears to have been open-fronted.	**High** – good evidential value because of its chronological relationship with slate tip (814) plus physical, historical and narrative links with Penny Rigg quarry and the local slate quarrying industry.	Spoil tip (814) Track (703) Rock cutting (815)	High High	19th century	
801	South wall of riving shed. Not much survives. Random coursed slate.	**High** – as above.	Spoil tip (814) Platform (805) Wall (802) Track (703)	High High High High	19th century	
802	West wall of riving shed. Random coursed slate built over and around the exposed bedrock.	**High** – as above.	Spoil tip (814) Platform (805) Wall (802) Wall (803)	High High High High	19th century	

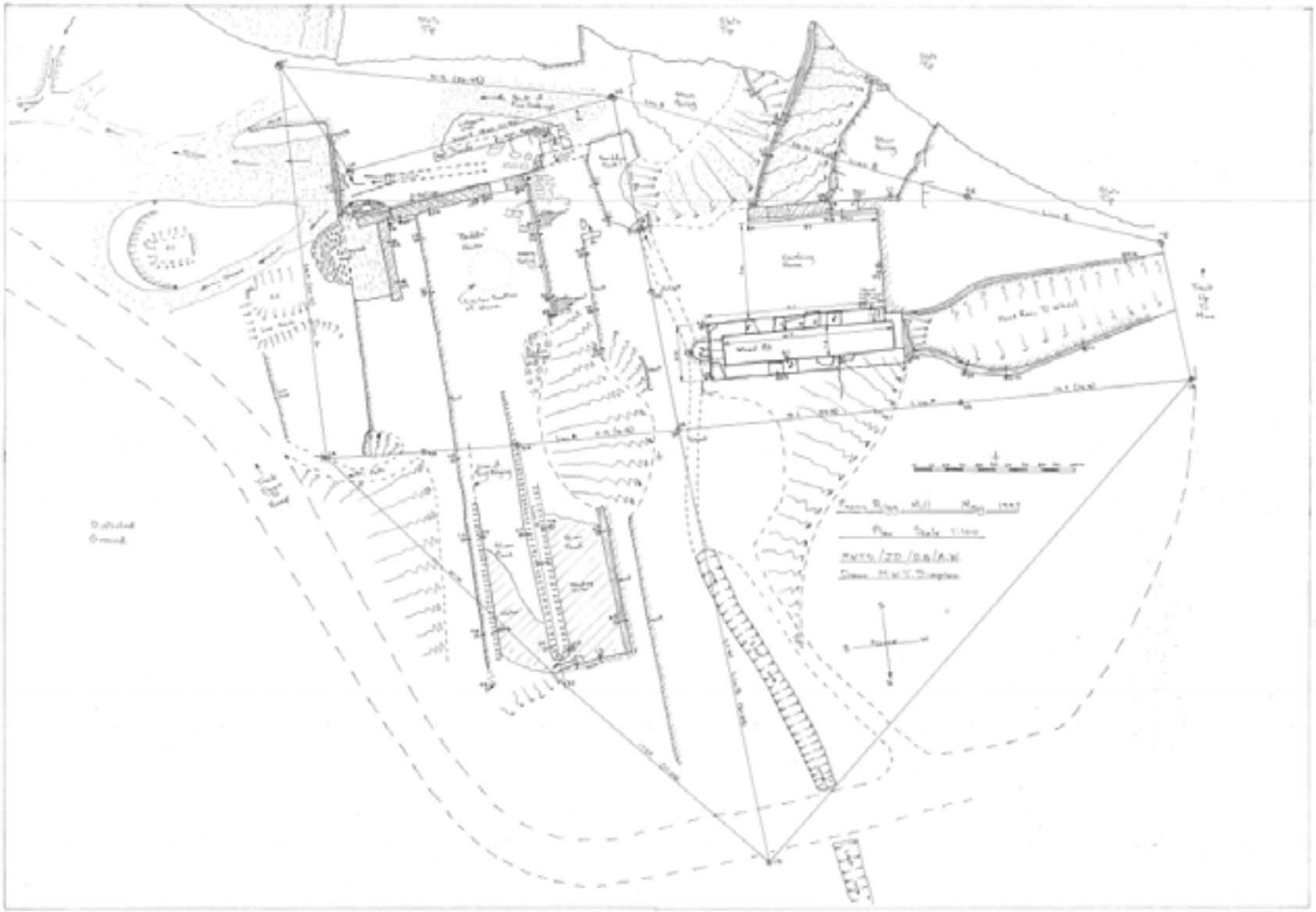
Context No.	Description	Significance	Associated with	Contribution to Significance	Date	Photo
803	N wall of riving shed. Random coursed slate built over and around the exposed bedrock.	**High** – as above.	Spoil tip (814) Wall (802) Track (703) Rock cutting (815)	High High High	19th century	
804	Natural bedrock forming the base of the W (802) and N (803) wall.	**High** – as above.	Spoil tip (814) Wall (802) Wall (803)	High High High	19th century	
805	Platform within the SW corner of the riving shed	**High** – as above.	Spoil tip (814) Wall (801) Wall (802)	High High High	19th century	

Context No.	Description	Significance	Associated with	Contribution to Significance	Date	Photo
806	Retaining wall within the riving shed forming the edge of platform (805)	**High** – as above.	Spoil tip (814) Platform (805) Wall (802)	High High High	19th century	
807	Stones that were originally placed end-on into the ground forming a partition within the riving shed.	**High** – as above.	Spoil tip (814)	High	19th century	
808	Rubbish tip. Mound of small pieces of slate (sweepings).	**High** – as above.	Spoil tip (814) Track (703)		19th century	

Context No.	Description	Significance	Associated with	Contribution to Significance	Date	Photo
811	Horse Crag quarry spoil tip. High-level slate tip.	**High** – good evidential value because of its chronological relationship with slate tip (814) plus physical, historical and narrative links with Penny Rigg quarry and the local slate quarrying industry.	Slate tip (813) Slate tip (814) Shed (812)	High High High	Later 19th century	
812	Much altered building, probably slate riving shed. Not shown on First Edition Ordnance Survey map. In use as a bothy	**High** – good evidential and historic value because of condition and associations with Penny Rigg quarry and the local slate quarrying industry. Some amenity value but not open for general public use.	Slate tip (813) Slate tip (814) Slate tip (811)	High High High	Later 19th century	
813	Slate tip. On same horizon as entrance to Horse Crag level and probably composed of waste from the closehead working in the level. Probably overlies a number of copper mine and mill features such as ore hoppers.	**High** – good evidential value because of its chronological relationship with development of Horse Crag Level and historical and narrative links with Penny Rigg quarry and the local slate quarrying industry.	Horse Crag Level (100) Shed (812) Slate tip (814) Slate tip (811)	High High High High	Later 19th century	

Context No.	Description	Significance	Associated with	Contribution to Significance	Date	Photo
814	Slate spoil tip. Composed of waste from the adjacent Penny Rigg quarry. Probably contemporary with riving shed (800). Overlies track (701) and leat (317) and contemporary with culvert (319).	**High** – of good historical and evidential value because of its chronological relationship with track (701) and the reuse of leat (317).	Level (815) Culvert (319) Leat (317)	High High High	Later 19th century	
815	Rock cutting leading to open entrance to mine level known as Quarry Level. Level driven SW to Penny Rigg quarry. Originally drained water from quarry for use in Penny Rigg copper mill. Spoil tip (814) derives in part from the driving of the level.	**High** – good evidential value because of its chronological relationship with slate tip (814) plus physical, historical and narrative links with Penny Rigg quarry and the local slate quarrying industry.	Spoil tip (814)	High	1870s?	

APPENDIX 2: CATMHS SURVEY OF PENNY RIGG MILL, 1999



APPENDIX 3: A GLOSSARY OF COPPER MINING AND QUARRY TERMS[7]

BUDDLE — A device for concentrating ore. In the mid-19th century these most usually took the form of a circular pit with rotating brushes. The tin from the STAMPS was fed into the centre or side of the pit and was graded by gravity, concentrating the heavy ore near the inlet point. These were often mechanically worked. Earlier buddles were trapezoidal in shape, and operated manually. A variation used in tailings works to treat sands and slimes was the ROUND FRAME: a freestanding, all wooden, mechanically actuated buddle, whilst a further variation was the dumb buddle, or dumb pit, which was not mechanically operated.

CLOSEHEAD — Underground slate quarry.

CULVERT — A small tunnel constructed to carry a channel of water.

DRESSING — The concentration of the copper or other ores contained in the rock excavated from the STOPES of a mine. Carried out on DRESSING FLOORS.

DRESSING FLOORS — An (often extensive) surface area on a mine where the various processes of concentration of ore took place – these consisted of crushing or stamping to attain a uniform size range, sizing (particularly on later mines), separation of waste rock, concentration (generally mechanically and hydraulically on tin mines, manually on copper mines), the removal of contaminant minerals (by calcination, flotation, magnetic separation), and finally drying and bagging for transportation to the smelter.

SETT — The boundaries of a mine or mining area.

SPOIL TIP, DUMP — A pile of waste material from a mine, which may contain primary waste (where this could not be disposed of underground), or waste from various stages in the dressing process. TAILINGS LAGOONS stored the extensive slimes from the final stages in the process; in

[7] Glossary adapted from 'A short Glossary of Cornish Mining Terms' citing online reference http://www.cornish-mining.org.uk/story/glossary.htm, accessed 30/10/16

	earlier mines these were flushed over cliffs or allowed to wash away in streams or rivers.
FINGER DUMP	A linear dump of waste material from a mine or quarry, flat-topped to allow material to be barrowed or trammed along it, and often equipped with a temporary tramway track.
JIG	A large mechanically or hand-operated sieve set in a tank of water in which ore could be separated by waste.
LAUNDER	A wooden trough used to carry water or other liquids; often used to power a waterwheel or to feed water or finely divided material in suspension around a dressing floor.
LEAT	An artificial watercourse, built to carry a supply of water to a mine.
LEVEL	Also known as an adit. A horizontal tunnel (usually driven into a hillside) in order to give access to a mine, and used for drainage or the hauling of broken ore. Deeper adits did not necessarily connect to surface, and were used to carry water back from distant workings to a pumping shaft.
MAGAZINE	Small, strongly built store containing explosives (gunpowder or dynamite); often circular, sometimes with additional enclosing walls to contain the blast of accidental explosions.
OPENWORK	A mineral extraction site open to the surface and similar to a quarry, but usually distinguished by its elongated shape and steep sides.
PROSPECTING PIT OR FOSSICKING PIT	A small pit dug in search of minerals, and almost always found in linear groups, often arranged cross-contour, or at right angles to the projected strike of known lodes.
RAGGING	Initial breaking up of sorted ore into uniform-sized pieces using a sledgehammer. Generally done by men or older boys prior to sending material to a mechanised crusher.
RID TIP	Waste rock from quarrying processes.

RIVING SHED	Buildings in which slates were split to form tiles.
SHAFT	A vertical or near-vertical tunnel sunk to give access to the extractive areas of a mine.
STAMP	A mechanical device for crushing ore-bearing rock to fine sand. Heavy, vertically-mounted beams (or later iron rods) carrying cast or forged iron heads were sequentially lifted and dropped onto the prepared ore beneath them by a series of cams mounted on a rotating drum; this usually being driven by a water-wheel or rotative steam engine.
STOPE	Excavated area produced during the extraction of ore-bearing rock. Often narrow, deep and elongated, reflecting the former position of the lode. Where open to the surface, stopes are termed OPENWORK.
TAILINGS	The waste sand and slime from a mine DRESSING FLOOR, not containing workable quantities of mineral.
TROMMEL	A cylindrical rotary screen used in the crushing house to separate crushed ore from larger fragments, the latter being sent for re-crushing.
VEIN	A linear area of mineralisation underground. Sometimes referred to as a seam. Generally vertical or near-vertical, and often extending for considerable distances along its strike.
WHEEL PIT	A structure built to house a waterwheel, often excavated and stone-lined, but sometimes freestanding.

APPENDIX 4: PENNY RIGG COPPER MILL PHOTOGRAPHIC CATALOGUE

Sorted by : Image Number

Image No	Film Type	Direction	Scale size	Description	Context	Photographer	Date
1	Digital	W	2m	Rock cut portal of mine level known as horse Crag Level or Tilberthwaite Deep Adit.	101	JP	July 2016
2	Digital	E	2m	Horse Crag Level entrance cutting.	102	JP	July 2016
3	Digital	S	2m	Concrete blocks close to the Horse Crag Level entrance cutting	102	JP	July 2016
4	Digital	N	2m	Stone platform, rectangular slab above rough coursed retaining wall.	104	JP	July 2016
5	Digital	N/A	2m	Iron compressor pipe.	105	JP	July 2016
6	Digital	N	2m	Shallow, linear, v-shaped gully running SW-NE.	106	JP	July 2016
7	Digital	SE	N/A	Flat topped linear spoil tip.	107	JP	July 2016
8	Digital	W	N/A	Smithy and Office with tree	201G	KC	July 2016
9	Digital	W	N/A	Smithy	201G	KC	July 2016
10	Digital	W	2m	Office	201G	KC	July 2016
11	Digital	N	1m	South wall of Smithy - external	202, 203	KC	July 2016
12	Digital	S	1m	South wall of Smithy, showing blocked door - internal	202	KC	July 2016
13	Digital	SW	0.5m	Valve for compressed air pipe	204	KC	July 2016
14	Digital	W	1m	West (back) wall of Smithy - internal	205	KC	July 2016
15	Digital	E	1m	West (back) wall of Smithy - external	205	KC	July 2016
16	Digital	N/A	N/A	Metal object in the west (back) wall of the Smithy	205	KC	July 2016
17	Digital	N/A	0.2m	Metal objects associated with the Smithy	205	KC	July 2016
18	Digital	N	1m	North wall of Smithy which is also the dividing wall between the Smithy and the Office	206	KC	July 2016
19	Digital	S	1m	North wall of Smithy which is also the dividing wall between the Smithy and the Office	206	KC	July 2016
20	Digital	W	1m	East wall of Smithy and buttress (208)	207	KC	July 2016
21	Digital	N	1m	East wall of Smithy and buttress (208) and hearth (209)	207	KC	July 2016
22	Digital	S	0.5m	North end of buttress	208	KC	July 2016
23	Digital	N	1m	Hearth	209	KC	July 2016
24	Digital	E	0.5m	Bellow hole and metal inlet pipe	210, 211	KC	July 2016
25	Digital	W	1m	West (back) wall of Office - internal	212	KC	July 2016
26	Digital	E	1m	West (back) wall of Office - external	212	KC	July 2016
27	Digital	N	1m	North wall of Office and window - internal	213, 214	KC	July 2016
28	Digital	S	1m	North wall of Office and window - external	213, 214	KC	July 2016
29	Digital	E	1m	East wall of Office - internal	215	KC	July 2016
30	Digital	W	1m	East wall of Office - external	215	KC	July 2016
31	Digital	N	N/A	Powder house - general view	220G	KC	July 2016
32	Digital	SW	1m	Powder house and small annex	220G	KC	July 2016
33	Digital	S	1m	South wall of powder house and door (222) - internal	221, 222	KC	July 2016
34	Digital	N	1m	South wall of powder house and door (222) - external	221, 222	KC	July 2016
35	Digital	W	N/A	West wall of powder house - internal	223	KC	July 2016
36	Digital	E	1m	West wall of powder house and protruding through stones - external	223, 224	KC	July 2016
37	Digital	N	1m	North wall of powder house - internal	225	KC	July 2016

Image No	Film Type	Direction	Scale size	Description	Context	Photographer	Date
38	Digital	S	1m	North wall of powder house - external	225	KC	July 2016
39	Digital	E	1m	East wall of powder house - internal	226	KC	July 2016
40	Digital	W	1m	East wall of powder house and protruding through stones - external	226, 227	KC	July 2016
41	Digital	W	1m	West wall and north wall of small outside annex	228, 229	KC	July 2016
42	Digital	E	N/A	Water wheel pit or housing.	300G	JP	July 2016
43	Digital	E	N/A	Water wheel pit or housing.	300G	KC	July 2016
44	Digital	NW	2m	S wall of wheel pit (300).	301	JP	July 2016
45	Digital	N	2 x 2m	S wall of wheel pit (300)	301	PM	July 2016
46	Digital	S	2m	N wall of wheel pit (300).	302	JP	July 2016
47	Digital	W	2m	E or end wall of wheel pit (300).	303	JP	July 2016
48	Digital	W	2m	E or end wall of wheel pit (300).	303	PM	July 2016
49	Digital	W	1m	Outfall tank for wheel pit (300).	304	JP	July 2016
50	Digital	SW	2m	Possible activity or building platform.	305	JP	July 2016
51	Digital	S	1m	Culvert opening (306).	307	JP	July 2016
52	Digital	N	1m	Open leat cut into natural slope.	308	JP	July 2016
53	Digital	S	1m	N continuation of leat 308.	309	JP	July 2016
54	Digital	S	N/A	Holding pond for wheel pit (300).	310G	KC	July 2016
55	Digital	SE	2m	Wall of coursed random rubble retaining the N side of the holding pond.	311	JP	July 2016
56	Digital	SE	1m	Wall of coursed random rubble retaining the N side of the holding pond - showing the curve to the wall	311	KC	July 2016
57	Digital	W	2m	Battered wall of the coursed random rubble retaining the E end side of the holding pond	312	JP	July 2016
58	Digital	NW	2m	Wall of coursed random rubble retaining the S side of the holding pond.	313	JP	July 2016
59	Digital	N	1m	Wall of coursed random rubble retaining the S side of the holding pond.	313	KC	July 2016
60	Digital	N	2m	Short retaining wall forming Sw end of the holding pond (300)	314	JP	July 2016
61	Digital	E	2m	Turf covered linear channel.	315	JP	July 2016
62	Digital	E	1m	Turf covered linear channel.	315	KC	July 2016
63	Digital	S	1m	Culvert entrance.	316	JP	July 2016
64	Digital	S	1m	Leat cut into slope to W with upcast bank to E.	317	JP	July 2016
65	Digital	N	N/A	Leat cut into slope to W with upcast bank to E.	317	KC	July 2016
66	Digital	N	1m	Outflow to leat (317).	318	JP	July 2016
67	Digital	W	1m	Outflow to leat (317).	318	KC	July 2016
68	Digital	N	1m	Culvert entrance.	319	JP	July 2016
69	Digital	S	N/A	Iron bolts on wall head of wheel pit (300).	320	JP	July 2016
70	Digital	N	N/A	Crusher house and ramps for access with holding pond (310) in the background	400, 310	JP	July 2016
71	Digital	NE	N/A	Crusher house and ramps for access	400-416	JP	July 2016
72	Digital	W	2m	Crusher house.	400	PM	July 2016
73	Digital	SE	N/A	Crusher house.	400	KC	July 2016
74	Digital	W	2m	E wall of crusher house, coursed randon rubble.	401	JP	July 2016
75	Digital	S	N/A	North end of east wall of crusher house showing relationship with east end of stone launder (312)	401, 312	JP	July 2016
76	Digital	W	2m	Joist holes in E wall of crusher house.	402	JP	July 2016
77	Digital	W	2m	Two joist or timber holes set vertically in N wall (401).	403	JP	July 2016
78	Digital	W	2m	Two timber slots in S wall (401).	404	JP	July 2016

Image No	Film Type	Direction	Scale size	Description	Context	Photographer	Date
79	Digital	W	2m	Small rectangular ground level opening in N wall (401) with part of water wheel pit wall (301).	405	JP	July 2016
80	Digital	W	0.2m	Two iron rods, possibly re-used drill rods or jumpers.	406	JP	July 2016
81	Digital	SW	2m	The S wall of the cursher house, coursed random rubble construction.	407	JP	July 2016
82	Digital	SW	N/A	Recess to carry high level or mezzanine floor associated with joist holes (402).	408	JP	July 2016
83	Digital	NE	2m	High level opening to W of gable in wall (407).	409	JP	July 2016
84	Digital	S	2m	Rectangular opening in doorway in wall (407).	410	JP	July 2016
85	Digital	S	2m	Two joist holes on internal face of wall (407) to E of opening (410).	411	JP	July 2016
86	Digital	S	N/A	Two eaves-level joist holes ont he gable of wall (407).	412	JP	July 2016
87	Digital	S	2m	Low dry stone wall built across and infilling the lower part of opening (410).	413	JP	July 2016
88	Digital	NE	2m	Inclined ramp or track above retaining wall 415 and leading to opening (410) in S face of wall (407).	414	JP	July 2016
89	Digital	SW	2m	Inclined ramp or track above retaining wall 415 and leading to opening (410) in S face of wall (407).	414	JP	July 2016
90	Digital	W	2m	Random rubble retaining wall below ramp (414).	415	JP	July 2016
91	Digital	NE	N/A	Inclined ramp above retaining wall (417/418) leadin to opening (409) in crusher house building.	416	JP	July 2016
92	Digital	NW	2m	Dry stone retaining wall between ramps (414) and (416).	417	JP	July 2016
93	Digital	NW	2m	Short lenth of dry stone retaining wall between N end of wall (417) and crusher house wall (407)	418	JP	July 2016
94	Digital	S	2m	Oval area of crushed mineralised rock	419	JP	July 2016
95	Digital	E	2m	Oval area of crushed mineralised rock	419	JP	July 2016
96	Digital	W	2m	Entrance to culvert at base of retaining wall (420)	420	JP	July 2016
97	Digital	W	2m	Relationship between entrance to culvert at base of retaining wall (420) and short length of pack wall	420, 421	JP	July 2016
98	Digital	W	2m	Short length of pack wall, possible forming part of a drainage channel.	421	JP	July 2016
99	Digital	SW	1m	Wrought iron bar.	422	JP	July 2016
100	Digital	SW	2m	Wrought iron bar shown in relation to the crusher house	422	PM	July 2016
101	Digital	SW	2 X 1m	Paved area composed of large rectangular stone slabs.	423	JP	July 2016
102	Digital	N	2m	Culvert opening.	424	JP	July 2016
103	Digital	SE	N/A	Rectangular sunken stone walled tank associated with culverts (424 & 426).	425	KC	July 2016
104	Digital	SE	2m	Short length of stone roofed culvert at SE corner of tank (425).	426	JP	July 2016
105	Digital	W	1m	Short length of stone roofed culvert at SE corner of tank (425).	426, 523	JP	July 2016
106	Digital	W	2m	Length of dry stone retainig wall joining with wall (428) to N.	427	JP	July 2016
107	Digital	NW	2m	Semi collapsed length of dry stone retaining wall joined to west with wall (427).	428	JP	July 2016
108	Digital	NW	2m	Length of low retaining wall E of tank 425.	429	JP	July 2016
109	Digital	SW	2m	Dry stone retaining wall in front and E of wheel pit (300).	430	JP	July 2016
110	Digital	SW	2m	Low stone retaining wall built against slope to W.	431	JP	July 2016
111	Digital	S	2m	Probable access track to crusher house (400G).	432	JP	July 2016
112	Digital	SW	N/A	Building and related structures associated with ore dressing and processing.	500G	JP	July 2016
113	Digital	W	2m	Coursed random rubble retaining wall forming the W side of the mill building.	501	JP	July 2016
114	Digital	NW	1m	Buttress built against N end of the mill wall (501).	502	JP	July 2016
115	Digital	S	2m	Shallow stone rubble plinth at the base of wall (501).	503	JP	July 2016
116	Digital	W	2m	High level rectangular opening with angled base/sill in S section of wall (501).	504	JP	July 2016
117	Digital	W	2m	High level rectangular opening with angled base/sill in N section of wall (501).	505	JP	July 2016
118	Digital	S	2m	Rectangular opening in the SW corner of the mill wall (507).	506	JP	July 2016

Image No	Film Type	Direction	Scale size	Description	Context	Photographer	Date
119	Digital	S	2m	S wall of mill building - internal	507	JP	July 2016
120	Digital	S	2m	S wall of mill building - internal	507	KC	July 2016
121	Digital	N	2m	S wall of mill building - external	507	JP	July 2016
122	Digital	N	2m	S wall of mill building - external	507	KC	July 2016
123	Digital	NW	2m	General view showing S wall of mill (507), culvert (426) and crushing house (400)	507, 426, 400	JP	July 2016
124	Digital	SW	2m	Stone retaning wall within the main mill building.	508	JP	July 2016
125	Digital	NW	1m	Foundation course for the mill wall (507).	509	JP	July 2016
126	Digital	N	2m	Rectangular opening in mill wall (507).	510	JP	July 2016
127	Digital	S	2m	Collapsed wall constructed from randomly coursed slate rubble.	511	JP	July 2016
128	Digital	S	2m	Collapsed wall constructed from randomly coursed slate rubble.	512	JP	July 2016
129	Digital	NW	2m	Retaining wall forming the E side of the mill building.	513	JP	July 2016
130	Digital	NW	2m	Rubble buttress forming a short continuation of retaining wall (513).	514	JP	July 2016
131	Digital	N	1m	Poorly constructed slate rubble wall partly collapsed.	515	JP	July 2016
132	Digital	S	2m	Poorly constructed slate rubble wall partly collapsed.	515	KC	July 2016
133	Digital	S	2m	Slate rubble wall (515), next to (507) with walls (508) and (511) abbutting	515, 507, 508, 511	KC	July 2016
134	Digital	S	1m	Stone faced bank forming E edge of settling pond (521).	516	JP	July 2016
135	Digital	S	1m	Stone faced bank forming E edge of settling pond (520).	517	JP	July 2016
136	Digital	NW	2m	Retaining wall built against slope forming the W wall of the settling tank area.	518	JP	July 2016
137	Digital	NW	2m	Retaining wall built against slope and forming the N edge of settling tank (520).	519	JP	July 2016
138	Digital	N	2m	Rectangular settling pond.	520	JP	July 2016
139	Digital	N	2m	Rectangular settling pond.	521	JP	July 2016
140	Digital	W	1m	Channel between settling ponds (520 &521).	522	JP	July 2016
141	Digital	W	1m	Support wall for top of steps (524).	523	JP	July 2016
142	Digital	E	1m	Angled flight of stone steps accessing the area immediately S of mill wall (507).	524	JP	July 2016
143	Digital	W	2m	Wall line surviving as tumbled foundation course	525	JP	July 2016
144	Digital	NW	1m	Exit for stone slabbed drain associated with culvert (426) to W.	526	JP	July 2016
145	Digital	W	2m	Retaining wall built against slope to W.	527	JP	July 2016
146	Digital	E	2m	Rectangluar buddle.	528	JP	July 2016
147	Digital	W	2m	Curved retaining wall E of buddle.	529	JP	July 2016
148	Digital	E	2m	Rectangular buddle with subsurface drain at E end.	530	JP	July 2016
149	Digital	W	2m	Rectangular buddle.	531	JP	July 2016
150	Digital	W	2m	Low retaining wall of boulder construction built against slope to W.	532	JP	July 2016
151	Digital	W	1m	Culvert and drain	534	JP	July 2016
152	Digital	SW	1m	Truncated section of culvert/drain.	535	JP	July 2016
153	Digital	W	2m	Culvert. Section of well constructed boulder wall.	536	JP	July 2016
154	Digital	E	2m	L-shaped depression between N end of wall (516) and mine track (705).	537	JP	July 2016
155	Digital	N	2m	Possible access track to SE corner of mill complex.	538	JP	July 2016
156	Digital	S	N/A	Mine tips with distinctive orange-brown colour of copper mineralisation	539	JP	July 2016
157	Digital	NE	N/A	One or possibly two slime or tailings ponds below modern road and W side of Yewdale bank.	600	JP	July 2016
158	Digital	N	2m	Large beck side bank.	601	JP	July 2016
159	Digital		2m	Low discontinuous retaining wall against SW bank.	602	JP	July 2016

Image No	Film Type	Direction	Scale size	Description	Context	Photographer	Date
160	Digital	W	2m	Low retaining wall below below modern road.	603	JP	July 2016
161	Digital	N	2m	Stone faced bank running W from beck side bank (601) to base of slope.	604	JP	July 2016
162	Digital	N	2m	Area N of bank (604) and definted to E by beck side bank (610).	605	JP	July 2016
163	Digital		2m	Channel at S end of bank 601.	606	JP	July 2016
164	Digital	N	2m	Gap at E end of bank (604).	607	JP	July 2016
165	Digital	NE	2m	Track between modern road and Horse Crag quarry.	700	JP	July 2016
166	Digital	NE	2m	Original track to mine and quarry from NW.	701	JP	July 2016
167	Digital	W	2m	Culvert with stone slab roof and stone sidescarrying outflow water from leat (317) under track (701)	702	JP	July 2016
168	Digital	N	2m	Track constructed against W slope with discontinuous stone revetment to E.	703	JP	July 2016
169	Digital	W	N/A	Inclined track from Horse Crag quarry on NE side of slate spoil tip (811).	704	JP	July 2016
170	Digital	N	2m	Track running NW from the modern road to the mine.	705	JP	July 2016
171	Digital	NW	2 X 1m	A 20m length of trackway terraced into slope to W.	706	JP	July 2016
172	Digital	W	1m	Riving shed	800G	KC	July 2016
173	Digital	S	0.5m	South wall of riving shed	801	KC	July 2016
174	Digital	W	1m	West wall of riving shed	802	KC	July 2016
175	Digital	N	1m	North wall of riving shed	803	KC	July 2016
176	Digital	W	1m	Natural bedrock forming the base of the west and north wall	804	KC	July 2016
177	Digital	W	1m	Platform within the south west corner of the riving shed	805	KC	July 2016
178	Digital	S	1m	Retaining wall within the riving shed	806	KC	July 2016
179	Digital	W	0.5m	Stones on edge forming a partion	807	KC	July 2016
180	Digital	NE	N/A	Horse Crag quarry spoil tip. High level slate tip.	811	JP	July 2016
181	Digital	N	2m	Much altered building, probably slate riving shed.	812	JP	July 2016
182	Digital	SE	N/A	Much altered building, probably slate riving shed.	812	KC	July 2016
183	Digital	W	N/A	Much altered building, probably slate riving shed.	812	KC	July 2016
184	Digital	SW	N/A	Much altered building, probably slate riving shed.	812	KC	July 2016
185	Digital	SE	N/A	Slate stip.	813	JP	July 2016
186	Digital	N	N/A	Slate spoil tip	814	JP	July 2016
187	Digital	N	N/A	General view showing, track (700) in the foreground, leat (317), track (703) and slate spoil tip (814)	814, 700, 703, 317	JP	July 2016
188	Digital	S	N/A	General view of the site looking south	N/A	KC	July 2016
189	Digital	N	N/A	General view of the site looking north	N/A	JP	July 2016
190	Digital	NW	N/A	General view of the site looking north west	N/A	KC	July 2016
191	Digital	SW	N/A	General view showing retaining wall (518), wheel pit (300) and crushing house (400)	518, 300, 400	KC	July 2016