Trease, Pendeen, Cornwall
The results of an archaeological watching brief during a second phase of conservation works

Cornwall Archaeological Unit 2016

Report No: 2016R005

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Client	**The National Trust**
Report Number	**2016R005**
Date	**19 May 2016**
Status	**Final**
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Acknowledgements

This study was commissioned by Andrew Banner, Consultancy Manager (Conservation), National Trust, and was carried out by Cornwall Archaeological Unit, Cornwall Council. The works programme was overseen by Mark Ward of pdp Green Ltd. of Truro.

The conservation works on site were undertaken by Rothwell Historical Restoration of Penzance. The Cintec drilling and installation were undertaken by South West Mining and Tunnelling Ltd, the construction and installation of the Trease Shaft grille were carried out by Jerry Harvey Engineering of Trewellard, shaft fencing and hedging were undertaken by Kernow Maintenance Services, the machine excavation was carried out by local contractor Tom Westfoot and the lightning protection was installed by St Ives Steeplejacks. NT Long Term Volunteer Luke Knowles assisted the author of this report with the installation of the geogrid over the shallow workings.

The drone-flown aerial photographic survey was produced for the National Trust by James Miles at Archaeovision (www.archaeovision.eu).

The Project Manager within CAU was Dr. Andy Jones.

Freedom of Information Act

As Cornwall Council is a public authority it is subject to the terms of the Freedom of Information Act 2000, which came into effect from 1st January 2005.

Cornwall Archaeological Unit is a Registered Organisation with the Chartered Institute for Archaeologists

Cover illustration

An overview of the tin floors at North Boscaswell during works.

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Fig 86. The completed Trease Shaft grille in place.

Abbreviations

CAU	Cornwall Archaeological Unit
CIfA	The Chartered Institute for Archaeologists
CRO	Cornwall Record Office
NT	The National Trust
OS	Ordnance Survey

1 Summary

Following the acquisition of the tenement of Trease at Pendeen to the north of St. Just, West Penwith, the National Trust commissioned Cornwall Archaeological Unit to undertake an archaeological assessment of the holding in 2014. In line with the recommendations contained in the resulting report, the National Trust carried out a preliminary round of decontamination and building conservation works in 2015, these being focussed on the southern buildings making up the North Boscaswell Mine mill which occupies part of this coastal site.

A second round of works took place between early January and early May 2016 to complete the conservation of the mine buildings and a nearby smallholders' field barn, manage the scrub which had become established over the site, install stock fencing to allow much of it to be grazed and to address the issues raised by the presence of a small number of potentially hazardous mine workings. The buildings conserved during this round of works consisted of those making up the northern section of the mine dressing floors including the remains of its exceptionally rare Merton calciner, as well as a field barn associated with the short-lived early 19th century miners' smallholding at Trease. The project was managed by pdp Green of Truro and undertaken by a range of locally-based contractors.

In conjunction with this work the National Trust commissioned Archaeovision to undertake a drone-flown detailed photogrammetric survey of the site to aid in its future interpretation.

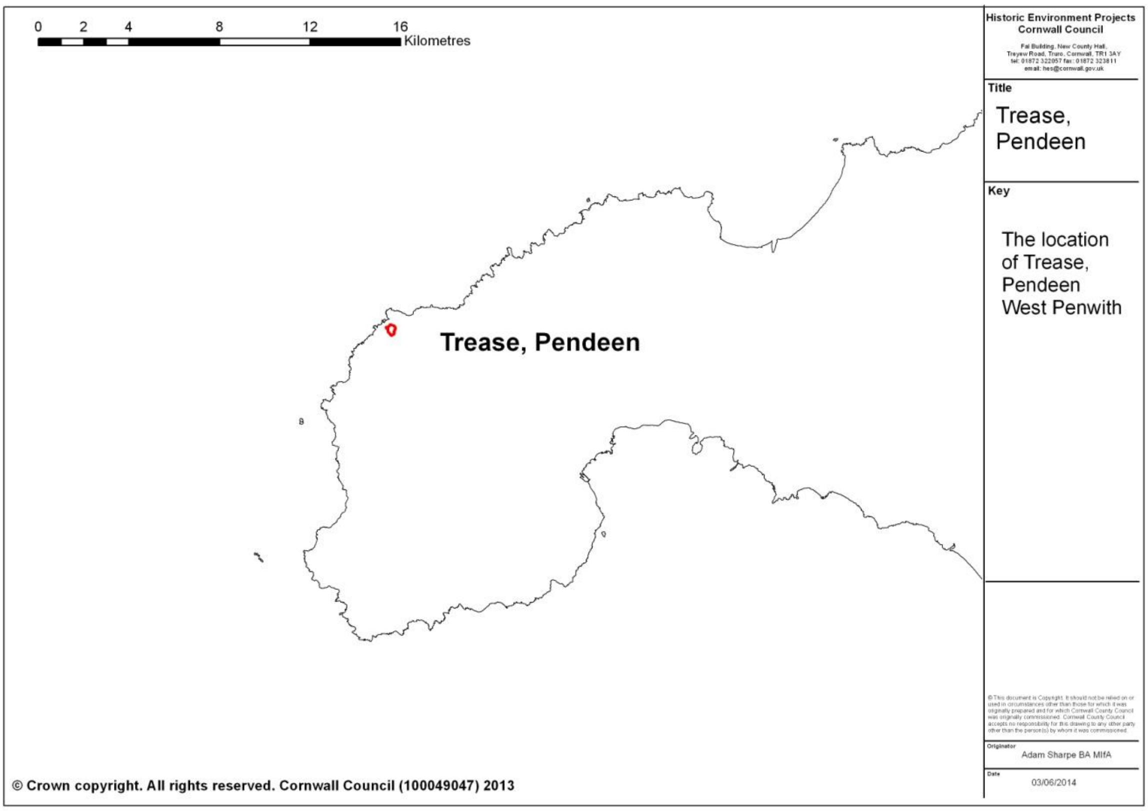

Fig 1. The location of Trease, Pendeen, West Penwith.

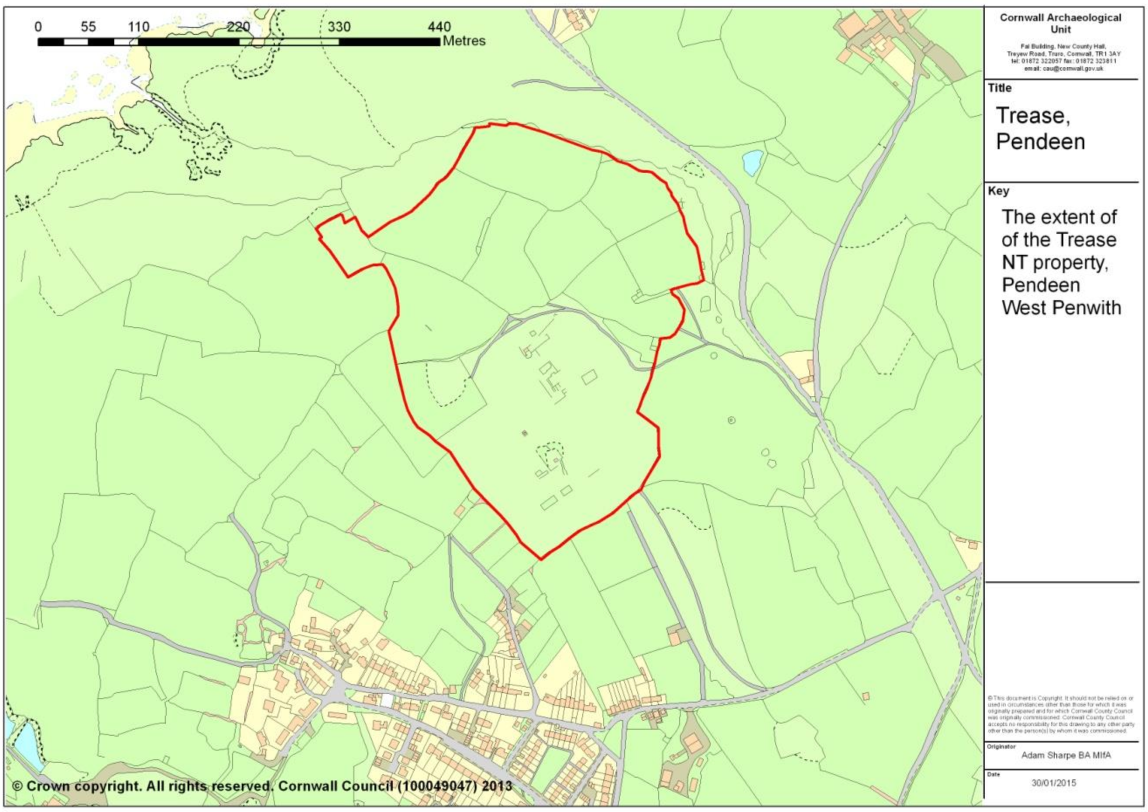

Fig 2. The extent of the NT property at Trease.

2 Introduction

2.1 Project background

In 2014 Historic Environment Projects (now renamed Cornwall Archaeological Unit) undertook an assessment survey for the National Trust of a recently-acquired land holding at Trease, Boscaswell (Sharpe 2014) (Figs 1 and 2). The site consists of a group of coastal fields typical of those found elsewhere in West Penwith, but to their south is a large area of enclosed formerly bracken and gorse-dominated scrubland siting the above-ground remains of North Boscaswell Mine. This mine had been worked during the 19th century (and almost certainly prior to this), but the majority of the surviving remains date from its reworking during the first decades of the 20th century, and include not only the footprint of a complete small-scale tin dressing mill, but also the remains of a very rare Merton Furnace used to calcine the tin concentrate at the end of the dressing process to remove incorporated arsenic, and the associated tin floors where the final cleaning up and concentration of the tin took place.

A programme of scrub vegetation clearance and the removal of contaminated rubble and other material was undertaken in 2015 and was followed by a first round of building conservation works, these largely being focussed on the masonry-constructed structures making up the southern end of the tin mill. A detailed measured plan of the site was drawn up by CAU, together with recommendations for further conservation works (Sharpe 2015). The re-hedging and/or fencing of a small number of mine shafts and a section of potentially unstable outcrop workings was undertaken in 2015 by Kernow Maintenance Services, the opening over Trease Shaft was fitted with a grille by Jerry Harvey Engineering whilst the installation of lightning protection to the calciner chimney was carried out by St Ives Steeplejacks.

A works schedule for the conservation of the remaining structures was drawn up in late 2015 by Mark Ward (pdp Green), Peter Bee (the National Trust Regional Building Department) and Adam Sharpe (CAU Projects Archaeologist). The contract was won by Rothwell Historic Restoration of Penzance and the works on site began in mid-January 2016. Concurrent with this, the local National Trust team undertook scrub management works in preparation for stock grazing and to allow an aerial photogrammetric survey of the site to be undertaken, whilst CAU was asked by the local NT Ranger to design a scheme which would secure backfilled outcrop workings beneath a section of the principal trackway around the site. CAU were requested to undertake an archaeological watching brief during the project and to report on its findings following the completion of the works in early May 2016.

2.2 Aims

The principal aims of the watching brief were to provide specialist guidance during the overall project to make sure that minimal damage occurred to features of archaeological significance and to ensure that the detail of any reconstructions was as authentic as possible, particularly in relation to the Merton Furnace, its dust chambers and the nearby dressing floors.

The CAU site plan was to be updated where any new features were revealed by the scrub clearance works. In addition, the drone-flown aerial photogrammetric survey of the site commissioned by the NT Regional Archaeologist commissioned had the aim of producing a metrically-accurate survey which would record the detail revealed through scrub clearance, the intention being that a combination of these surveys would be utilised in the subsequent interpretation of the site.

The objectives of this project are to produce a written report summarising the findings of the watching brief and setting out recommendations for any further work which might be required on site, as well as to produce an entry to the OASIS/ADS-Online database.

2.3 Methods

2.3.1 Desk–based assessment

A desk based assessment had been undertaken for the 2014 assessment of the site (Sharpe 2014); historical and other information utilised in this report is derived from the previous study, together with the findings of the 2015 works.

2.3.2 Fieldwork

CAU attended a number of pre-start site meetings with National Trust and pdp Green staff to determine the specifications for the project. Subsequent visits were made to the site during the period when the conservation works were being undertaken to guide the contractors on matters of detail, identify and record newly-revealed elements of the site, produce a record of the works undertaken, and record any significant artefacts prior to their removal to safe storage. The CAU Archaeologist also liaised with the National Trust Regional Archaeologist, Building Surveyor, Property Manager and local NT countryside staff throughout the project. The excavation of the outcrop workings and installation of a geogrid to secure its loose fills were supervised by the CAU Archaeologist.

The nature, general dimensions and condition of elements of the site were recorded in note form, whilst measured sketch survey was undertaken during the clearance programme where new features were revealed, allowing the composite site plan and that for the mill complex to be updated. High resolution digital record photographs were taken during the project.

2.3.3 Fieldwork: photographic recording

The photo record comprised:

- general views of the site and of work in progress;
- a base record of the standing structures affected by the works, particularly their elevations, as well as before, during and after photographs of significant structures;
- examples of structural and architectural detail where relevant.

Photographs of details were taken with lenses of appropriate focal length;

2.3.4 Post-fieldwork

Drawing up field records

The site surveys created during the 2014 assessment and the 2015 work programme were updated here required, redrawn utilising a CAD programme and stored in *.dwg format.

Creation of site archive

This comprised:

- The archiving of digital colour photographs (stored according to CAU and NT guidelines), copies of images being provided to the client;
- Archiving of the project records according to NT guidelines;
- Completion of the Historic England/ADS OASIS online archive index.

Archive report

This written report includes the following sections:

- Summary
- Project background
- Aims and objectives
- Methodologies
- Location and setting

- Designations
- Site history
- Watching brief results
- Recommendations
- References
- Project archive index
- Supporting illustrations: location map, plans and elevations, photographs

A digital (PDF) copy of the report, illustrations and any other files has been lodged with the Cornwall HER. Paper copies of the report have been distributed to the client, to local archives and national archaeological record centres.

Archive deposition

An index to the site archive has been created and the archive contents prepared for long term storage by the NT, in accordance with its standards.

The archive comprises the following:

1. All correspondence relating to the project and a paper copy of the report together with an electronic copy on CD, stored in an archive standard (acid-free) documentation box
2. Copies of the record photographs stored on a CD in a format agreed with the NT.

The project archive has been deposited with the National Trust.

3 Location and setting

See Figures 1 and 2.

The site consists of most of the former tenement of Trease, Pendeen, centred at SW 38011 35174 and covers 115,500 square metres (11.5 Ha). Trease is sited on the West Penwith coastal plain to the north-east of the hamlet of Lower Boscaswell and to the south-west of Pendeen Watch; Geevor mine lies not far to the south-west. The land immediately to the north-east and east of the field barn is not owned by the National Trust, but is on land worked from Pendeen Manor Farm. The site is accessed via public footpaths running across land owned by others from the settlement of Lower Boscaswell and from the road through Boscaswell Moor leading to Pendeen Watch. The South West Coast Path runs through the cliffland just to the north of the property.

The site covered by the watching brief extends to the boundaries of the recent NT property acquisition, but included a strip of land to the south which was utilised as the site access and for the contractors' parking and compound area, and a small area of the field to the north-east and east of the Trease field barn (permission for the use of these areas being given by Terry Davey, the tenant farmer at Pendeen Manor Farm) for the duration of the project.

The underlying bedrock within the southern fifth of the property consists of the Lands End Granite, whilst that within the remainder of the site to the north consists of metamorphosed Upper Devonian Mylor series mudstones and siltstones. Trease Shaft was sunk on the surface contact between the two geologies on the North Boscaswell Lode which strikes roughly northward towards the coast at Mill Zawn and southwards across Boscaswell Lower Downs, crosses the B3306 just to the east of Boscaswell crossroads and the former site of Boscaswell Downs Mine and continues across Boscaswell Higher Downs to the site of Wheal Powle.

A mining search of the property undertaken for the National Trust by Cornwall Consultants Ltd. refers to a schematic plan of Boscaswell Downs Mine which shows twelve lode outcrops within the property and one bordering its eastern boundary.

Within the property, outcrop workings are present on only one of these lodes – that running from Treweek's Shaft through Trease Shaft and out towards the cliffs, and it is likely that many of the remainder of the lode outcrops are hypothetical only. Wheal Fortune Shaft, marked on only one mine plan which was described as '*schematic, undated and of poor quality*' by Tony Bennett of Cornwall Consultants could not be found on site, though its probable location was identified; this shaft seems likely to have been backfilled two centuries ago. Dines (1956) reported that Trease Shaft was 50 fathoms (around 100m) deep, and also suggested that Trease Shaft and Wheal Fortune Shaft were one and the same.

4 Designations

4.1 International

The whole of the Trease property falls within Area A1 of the Cornwall and West Devon Mining Landscapes World Heritage Site.

4.2 National

The coastal strip immediately to the north of the property is designated as part of the Carn Aire to Carrick Du Site of Special Scientific Interest (SSSI).

4.3 Regional/county

Trease is part of the Cornwall Area of Outstanding Natural Beauty (AONB), and was formerly designated in the Cornwall Structure Plan as an Area of Great Landscape Value (AGLV) and an Area of Great Scientific Value (AGSV). The coastal strip (to the north of the Trease property boundary) is designated as a RIGS (a Regionally Important Geological and Geomorphological Site).

5 Summary site history

This site backing Boscaswell Cliffs consists of coastal farmland to the north which is likely to have been in agricultural use since late prehistory and which has a place name which originated during the early medieval period, this deriving the Cornish 'Tre': farmstead and 'Rid': ford, reflecting the location of the early farm near a crossing point across the nearby stream. The location and extent of the medieval farmstead is unknown as all evidence for it has been lost. An area in the southern part of the site appears to have long been croft – enclosed rough land.

A miner's smallholding incorporating a small cottage, a barn, eight small fields and an area of croft was established at Trease during the early decades of the 19th century. The occupation of this small farm by multiple families seems to have been relatively short-lived, however, and it had been abandoned by the time of the 1881 census, its land having since been worked by neighbouring farmers.

Alluvial and eluvial tin had been won from the neighbouring valley to the east since the late medieval period, Gerrard recording 'Whele Boscaswell' as a tinwork in this general area in 1508 (BL ADD 24746/216) as well as a stamping mill at Pendeen in 1637 (CRO 88/1/40), and these alluvial deposits were periodically re-tried until at least 1782. The date at which underground mining began on the upper parts of the lodes which traverse this area is unknown, Noall (1973) suggesting that work might have begun in parts of the wider Boscaswell sett by 1788. Noall noted that Boscaswell Downs was advertised for sale as a '*productive and valuable tin mine*' in 1813 when there was already a steam engine at work (in the southern part of the sett), and by 1837 Boscaswell Downs was employing 182 men, 5 women and 59 boys and was operating four beam engines for pumping, winding and stamping as well as two water wheels. Parts of the mine had been worked to 220 fathoms (approximately 440m) from surface by this date.

Shafts and other features associated with the Boscaswell Mines were clearly well-established by 1840, when they were depicted on the St. Just Tithe Map. By this date, Treweek's Shaft had been sunk to 80 fathoms (approximately 160m) from surface. In

1872, a '*magnificent copper lode*' (the Albert Lode) was exposed within a foot of surface within the sett but not long after Boscaswell Downs became unprofitable and its assets had been seized to cover its debts.

Whilst the lodes to the south had historically proved very productive, those to the north of Treweek's Shaft seem to have been little worked by the mid-19th century, and were clearly ripe for re-trying. A small-scale operation had been established at the North Boscaswell site by 1840 (Tithe Map evidence) and a shaft and an adjacent small building were marked at Trease on the *circa* 1878 OS mapping. This operation is poorly documented, but it is assumed to have been a small-scale 19th century working of North Boscaswell Mine, possibly as part of Boscaswell Downs.

Boscaswell United Mine (as it became known) ceased work during the later part of the 19th century but in 1906 the old North Boscaswell Mine was re-inspected and a company was formed to work the setts of Boscaswell Mine, Boscaswell Downs and Pendeen Consols under the title of the North Boscaswell Mining Company (the company being reformed as the Boscaswell United Tin and Copper Mining Company Ltd. in 1912). See Figure 3 for the locations of the principal surface components of the mine and Figure 5 for the 2014 CAU survey of the mine site.

The mine was accessed from two principal shafts – (New) Trease within the property and Treweek's to its south (Treweek's Shaft being re-worked by Geevor Mine during the second half of the 20th century). Initially, the mine was equipped with a sinking headframe and a temporary winder house. Once the initial shaft works were complete mine buildings were erected near Trease Shaft to house a horizontal winding engine and its boiler, and to provide accommodation for the miners, smiths, carpenters and office staff. The lode opened up from Trease Shaft was found to be two feet (660 mm) wide, carrying 56 lb (24.88 kg) of tin per ton, as well as arsenic and copper. A further lode had been opened up in the 180 level east which was believed to be the copper lode found just before the closure of Boscaswell Downs in the 1870s. This was also reported as carrying good quantities of tin (Noall 1973).

A dressing plant acquired in 1909 from a short-lived re-working of Worvas Downs near St. Ives was housed in a compact mill which was connected to Trease Shaft by an elevated tramway; a further tramway linked Treweek's Shaft to Trease Shaft. Some of the plant in the mill was unusual, including its Record and Pinder tables, whilst the steam for the horizontal compound mill engine was generated using two free-standing Cochran vertical marine boilers, again purchased from Worvas Downs together with their steel-framed, sheet steel clad boiler house.

A flow sheet for the dressing floors discovered in the Geevor Archive proved useful in explaining the functions of many of the machine bases recorded on site and the former interconnections between them, despite the complete loss of the launders and pipework which would have been used to transfer material between different process areas on the site. The demolition of the superstructure of the mill building has undoubtedly removed considerable diagnostic detail of this type. Nevertheless it is possible to understand the general arrangements of the site and the way in which it functioned; the internal arrangements of the mill can also be inferred to a fair degree from other contemporary sites of this type.

North Boscaswell Mine was small-scale, 11 men being employed underground and six at surface in 1906. The numbers rose steadily until 1909 when the total number of employees was 31 (16 underground and 15 at surface) suggesting considerable development work, and the workforce was more less the same in 1910 (10 underground and 20 at surface, the increase in the number of surface staff presumably reflecting the mill construction work going on at the time). In 1911 only two men were working underground, but in the following year there were 15 men underground and 14 at surface; in 1913 the numbers were more or less the same, with 20 underground and 10 at surface.

The mine was briefly suspended in 1911 and again in 1913, and was placed on care and maintenance between 1914 and 1915 following the outbreak of the Great War. In

1918 the mine was clearly restarted, the 29 men recorded as being employed underground and 19 at surface suggesting that there was an intention to upscale operations at the site, but the mine was recorded as having been suspended by the end of the year. In all, only 22 tons of tin are recorded as having been produced during the whole of this period of operation (Noall 1973).

Attempts were made to re-start the mine in 1922, but it was suspended yet again soon afterwards. It remained in this condition until around 1927, following which the company was wound up, the machinery was sold off or scrapped and most of the buildings were dismantled to recover re-usable materials. The mine sett was taken over by Geevor in 1937 and the underlying lodes were successfully worked in depth from the 1960s until the late 1980s.

The brick superstructure of the Merton Furnace at the foot of the mill was completely demolished following the closure of the mine, but efforts to recover its machinery for scrap were not completed (Fig 10); some of its cast iron components survived *in situ* within its interior or scattered on the ground surface nearby, though the majority of its brickwork was removed from site presumably for re-use. Episodes of vandalism a few decades ago resulted in further (in some cases substantial) damage to this component of the site, resulting in the partial demolition of its stonework and brickwork, together with damage to some concrete components. In addition the heat generated by the furnace and the presence of hot, acidic gases when it was functioning had attacked the mortar binding together the remaining parts of the brickwork of which its superstructure had been constructed.

The site remained abandoned, and lying as it did within an area of croftland, it gradually scrubbed in and became increasingly invisible and inaccessible. For generations the mine buildings were used as a playground by local children, resulting in occasional episodes of vandalism, some of these resulting in significant damage to parts of the Merton calciner building and its adjoining dust chambers. The dust chambers were eventually (and given their contamination by arsenic soot, hazardously) occupied by a homeless person. The Trease field barn gradually became derelict and dangerous and its wall openings were eventually blocked off to prevent entry to the building (Fig 13); during the 1980s the remains of the nearby farmhouse were consolidated by a local group, whilst the enclosed farmland was rented out as pasture to a local farmer.

In 1998 the potential national significance of the Merton furnace was highlighted in an article by Peter Joseph in the Journal of the Trevithick Society based on his historical research and a sketch survey he had undertaken of the site. In 2013, the National Trust acquired the Trease property from its owner, Mrs. Grenfell, and in 2014, Cornwall Archaeological Unit undertook an archaeological assessment of the property (Sharpe 2014). An initial round of conservation works to parts of the North Boscaswell mill was undertaken in the following year and was the subject of an archaeological watching brief (Sharpe 2015).

6 The 2016 Archaeological consultancy

6.1 Scope of works

The building conservation works undertaken in 2016 were focussed in four principal areas of the site (below). Other safety and landscaping works were undertaken at the same time by the local NT Ranger team and by external contractors. The proposed works are described in brief in relation to each area of the site.

6.1.1 The Merton calciner, associated furnace, dust chambers and chimney.

North Boscaswell's Merton Furnace was not typical of the arsenic calciners constructed on almost all other Cornish mines (see Section 9 of this report) in that the calciner was a free-standing, largely brick-built structure set within an enclosing building (see Fig 10). Whilst most of the walling of the enclosure building has survived, the brickwork of the furnace itself has been wholly demolished down to the granite base on which its lower calcining bed had been constructed.

Structural cracks in the calciner building and the northern walling of the dust chambers where the arsenic soot had been collected required stitching with stainless steel helicoil bars and reinforcing with regularly-spaced vertically set stainless steel bars. The roof of the northern dust chamber was to be reconstructed to confer additional stability to this element of the structure, as also was a section of the eastern wall of the calciner building and its incorporated flue opening. Ivy was to be stripped from the chimney and any minor repairs found to be required undertaken. The calciner bed was to be re-formed using salvaged bricks and reinforced lime concrete, rusted-out steel supports under the walkway were to be removed and replaced, all internal and external walls were to be repointed where required and capped (except in those limited areas where Nationally Rare bryophytes had been recorded), and a steel safety barrier was to be installed at the entrance to the walkway. The furnace was to be partially reconstructed and the corroded iron hearth door frame provided with a stainless steel support. The capping stones on the walling defining the edge of the walkway to the west of the dust chambers were to be re-set and any live ivy and bramble roots within the structure as a whole were to be removed or spot treated.

6.1.2 The tin floors, the external buddle and the building to the north east.

Repairs were required to the brickwork facings of the two larger buddles. In this part of the site and a root barrier was to be installed external to the northern buddle, the larger open channels were to be plank-lined and covered with grilles to remove trip hazards, broken sections of concrete flooring were to be cut out and replaced and the walling of the settling tanks on the northern side of the tin floors was to be repaired. The wall extending to the east of the tin floors and the building at its eastern end were to be repointed and repaired where required, as was the southern wall of the tin floor building where a localised collapse had taken place.

6.1.3 The dressing floors to the north of the Californian Stamps.

A range of works were required within this area including repairs to those machinery plinths which had originally been constructed of poor quality concrete, the repointing of masonry walling, the installation of grilles over open channels, and the installation of new timbers in the four slots in the floor at the lower end of the dressing floors where vanning tables had been sited, and those which had originally held the substantial foundations for the Californian Stamps. The amorphous hollow in the floor of the boiler house was to be infilled with granular material and the tank in the north-western corner was proposed to be grilled over. A further safety grille was to be installed between the two northern mill engine loadings. Some minor repairs were required to broken sections of concrete flooring, whilst the edges of the floors and the site of a piece of unidentified machinery at the head of the lower floor were to be backfilled and underpinned with concrete grout where these areas had become voided and unsupported.

6.1.4 The Trease smallholding field barn.

On this structure the ivy cloaking its southern wall was to be removed and any substantial stumps spot treated to prevent damaging regrowth. The wall corners had been repointed in a cementitious mortar by the previous owner of the land, whilst all doorways and windows into the structure had been blocked in with a mixture of concrete blockwork and masonry. Its roof had collapsed, and the original first floor had been lost many years ago. The barn's ground floor door blocking was to be removed and rubble removed from the interior of the building, all open joints on the walls' external faces were to be repointed in lime mortar and the wall heads capped with roofing slates to prevent water ingress. The masonry which formerly carried the steps up to the doorway on the southern elevation was to be stabilised by localised rebuilding and repointing following the removal of the covering scrub vegetation, soil and rubble, and subsequently topped with layers of geotextile and granular rocky material.

6.1.5 Mine shafts and openworks

Two hedged mine shafts (one to the north of Trease Shaft, the second adjacent to the eastern boundary of the property on the Boscaswell Down adit) had been re-hedged and fenced by Kernow Maintenance Services in 2015, whilst a further pair in the northern fields had been fenced around (see Figs 22 – 24). The outcrop workings extending northwards from Trease Shaft had been fenced on both sides to mitigate the potential hazard they posed to grazing stock and to walkers. Sections of these backfilled outcrop workings were seen to be exhibiting signs of subsidence and the northern end of these early workings was traversed by a track used by walkers, stock and (occasionally) by NT vehicles. CAU recommended that the ground here should be stabilised by the installation of geogrid to an appropriate specification.

An inspection of Trease Shaft following the removal of covering scrub showed that it had been covered over with railway sleepers (almost certainly by Geevor Mine prior to 1991 when the mine finally closed, see Fig 17). The temporary lifting of the sleepers showed that the concrete slab which had formerly sited the mine's headframe was of substantial construction, but that it overhung the rock faces of the underlying shaft on all sides by at least a metre. The National Trust produced a specification for the fabrication of a galvanised steel grille to be fixed over the shaft onto sections of the concrete which could be confirmed as being founded on bedrock.

6.1.6 Site clearance works

The National Trust Ranger had cut down a very large proportion of the gorse and bracken scrub across the site utilising a tractor-mounted flail in 2015 and early 2016, revealing some additional earthwork detail (see Figs 18 – 19). These features were sketch-surveyed by CAU in 2016. Bracken across this part of the site had been treated with Azulox by Kernow Maintenance Services in the autumn of 2015 to substantially prevent its regrowth. Further hand clearance of scrub in and around the mine service buildings at the southern end of the site had been undertaken by National Trust Long Term Volunteers in January 2016. No additional detail was revealed within the buildings as a result of these activities with the exception of a short, detached section of a square section brick-built chimney, this originally probably being part of a smith's forge.

No conservation works were scheduled to these structures during the 2016 works programme.

6.2 Results

The works undertaken in 2016 within each area of the site are described below.

6.2.1 The Merton calciner, furnace, dust chambers and chimney

This small complex of buildings at the foot of the North Boscaswell dressing floors contained the equipment used to remove any arsenic and sulphur contained within the ore concentrate. The ore was roasted to a high temperature in a two deck Merton Calciner, a type of calcining hearth which was used on only a very small number of mine sites in Britain (see Fig 74). The arsenic, converted to a 'fume' during the roasting process on the hearths, passed via a short horizontal flue to the adjacent paired dust chambers where it cooled and crystallised out, the fume being drawn through them by the draught from an attached short chimney stack, which also vented any sulphurous gases over the surrounding landscape. The tin concentrate was roasted on each hearth floor in turn, being swept around the cooler upper hearth by a toothed rabbling arm and then passing down to the hotter lower hearth through a slotted iron casting, finally being discharged by the lower rabbling arm into a collection vault underneath the calciner via a second slotted casting built into the floor of the lower hearth on its eastern side.

The Merton Calciner and attached furnace had been constructed of brick on granite bases, and in order to counteract the destructive expansive forces which would have been exerted by the heat within them, both had been strongly clamped together using steel bars retaining vertically- and horizontally-set steel joists at their outer ends.

The demolition of the brick superstructure of the calciner in the attempt to recover its iron components for scrap on the closure of the mine has exposed its remaining lower section to the elements for many decades. Weakened by exposure to hot, acidic gases when in use, much of the remaining exposed mortar (including that bonding the surviving lower calcining bed) has disintegrated. Furthermore, an episode of vandalism two decades ago had resulted in significant damage to some components of the calciner and the adjoining dust chamber, whilst advanced corrosion of the ironwork which formerly supported the high level walkway to the former loading hopper on top of the calciner had left this feature unsupported, cantilevered and potentially unstable. Finally, part of the inherently weak poor quality mass concrete arched roof on the northern dust chamber had collapsed, whilst unconstrained side-thrusts on the upper section of the building's northern wall roof had resulted in movement within its northern and western walls; significant movement cracks were recorded in the northern wall of the calciner building and the western wall of the northern dust chamber. These weak points were to be stitched with stainless steel bars to tie the adjacent sections of walling together and reinforcement bars to strengthen the northern wall of the northern dust chamber.

The first works to be undertaken in this part of the site consisted of the infill of the vandalised section of walling to the southern dust chamber east wall using recovered masonry (Fig 54) and the rebuilding of the eastern wall of the northern dust chamber, including a reconstructed flue opening (Fig 55), the proportions of this partly-lost feature being based on the presence of its surviving upper and lower lintels and its intact northern reveal. A section of the head of the northern calciner enclosure wall was also reconstructed at this time. These works added much-needed strength to the calciner enclosure building.

This, in turn, enabled a strongly-constructed Acro prop and timber-supported plywood formwork to be erected on which the replacement section of the lost eastern end of the northern dust chamber roof could be cast (Fig 58). The poor quality and, in places, rough finish of the underside of sections of the original roof clearly indicated that this structure had never been intended to be the permanent feature of the site which it has become, having now survived for over a century. Each dust chamber roof had clearly originally been cast in three sections, stones having been laid over the original timber formwork and weak concrete cast over these, before a 35mm thick skin of stronger concrete was skimmed over the roof as a whole, as was revealed during the cutting back of the broken edge of its remaining section. As a result, shrinkage cracks had developed along the edges of the original joint lines on both roofs, which had allowed water to percolate into the interior of the dust chambers.

In order to key the new and old work together a number of stainless steel dowels were drilled into the western edge of the old roof, whilst additional stainless steel reinforcing bars were inserted into masonry joints in the western wall of the calciner enclosure and were incorporated into the three tonnes of concrete required for the new section of roof in order to tie it into the existing structure. The new concrete incorporated 50mm long polypropylene fibres in order to further strengthen the finished work and reduce any tendency of the mix to slump between emplacing and curing (Figs 59 & 60). Given the poor weather experienced in early February when this aspect of the work was being undertaken, the finished arch was protected from the weather under a waterproof tarpaulin whilst it was curing. Some further rebuilding in reclaimed brick and rendering in a cementitious mortar was undertaken to blend the underside of the new concrete arch into the inner wall faces of the dust chamber.

The leakage of rainwater through the original construction joints in the roof was clearly evident during the winter of 2015/16, and it was noticeable that erosion and degradation of the concrete at these interfaces had taken place. The original roof concrete was also found to be permeable, resulting in spalling of the weak concrete facing forming the underside of the roofs. As a result, the original construction joints were partially cut out and repaired and a proprietary waterproofing solution (Fosroc Brushbond FLXIII) was applied to the upper surface of the whole of the old section of the roof following the removal of all loose surface matter and the grouting of cracks and joints (Figs 60 & 61).

The valley gutter between the two roofs had become partially infilled with soil and grass, and its outlet pipe had become blocked, exacerbating water penetration issues. This area was cleaned out, sections of failed concrete repaired and the drain pipe reinstated.

Within the dust chambers, a section of the dividing wall had evidently collapsed at some point in the past and had been roughly patch repaired to prevent any spreading of the lost area. In addition, almost all of the angled holes within this wall which had allowed the gases to be drawn from the first to the second chamber had been blocked up with old bricks set in expanding foam. The bricks and foam were removed, and the openings were made good where found to have been damaged. The roughly patched section of the wall was carefully demolished and reconstructed so as to incorporate the angled gas transfer holes which would originally have been incorporated into this lost section of walling.

The lower section of the internal south wall of the calciner building had originally been abutted by the brickwork of the furnace itself, and had not originally been internally pointed, though the exposed wall face above the furnace top had been cement pointed, and incorporated the outline of the end of a feed hopper. In order to retain the distinction between the upper and lower sections of the wall, the joints in the lower part was repointed using a lime mortar (Fig 56), whilst very limited repairs were made to the upper level pointing in a cementitious pointing mix. The wall head stonework was re-set and its upper joints were repointed to ensure that any rainwater falling on it would be shed, and could not make its way into the wall core.

The NT Buildings Department was concerned about the cracking and probable destabilisation of the northern and western walls of the northern dust chamber, it being considered that this had been caused by unconstrained side thrusts imposed by the arched concrete roof of this building on the heads of these walls. Although no active movement cracks were evident, it was decided that a long term solution would be required to strengthen these walls, and as a result a specialist company based in Bodmin was contracted to install Cintec reinforcing bars in grout-filled oversized drill holes through the cores of these walls over their full heights (Figs 62 – 64). In addition, one 5m long horizontal bar was to be installed along the length of the northern wall of the northern dust chamber to tie its masonry together. The outer sections of the cores from the drilling works were retained to disguise the drilled entry points for the Cintec bars.

This work was undertaken at the beginning of March 2016, prior to the repointing and helicoil stitching of the cracked joint fills (Figs 57 & 65). This was a prolonged process given the need to accurately and securely set up the drilling unit at right angles from the wall and to ensure that the drill holes were correctly aligned and the necessity to repeatedly withdraw and clear the core drill at the tip of the rods before extending the drill string in 300mm steps. The first hole to be drilled was the 5m long x 50mm diameter horizontal hole through the length of the north wall of the building roughly 600mm down from its wall head. The drilling team then moved onto the technically more difficult 75mm diameter sub-vertical holes through the core of the wall and spaced along its length. With these, the team experienced repeated problems with extracting the cores as some slipped from the drill head back into the drill holes, whilst in other areas the drill path ran partially between the inner and outer wall skins, and the small rubbly stones incorporated into the rab wall core were converted to gravel by the drilling process, making this material almost impossible to extract. Penetrating rainwater over the course of a century had also created a number of voids between stones in the wall core, which the drill tended to try to follow rather than the desired line. Finally, each vertical drill hole required a new rigid set-up based on bespoke scaffolding, each of which took time for the drillers to erect. As a result, the drilling programme was rather more protracted than had initially been anticipated, and after some discussion between the site archaeologist and the engineers, the vertical drill holes were reduced from 3.0m to 1.5m in length. A free-flowing, relatively fast-setting specialist grout was pressure injected into woven socks surrounding the stainless steel reinforcing rods during mid-March 2016, completing this element of the works.

Galvanised steel lintels were installed above the internal heads of the two dust chamber doors given that the original small-section bridge rail lintels had corroded badly. This required the old lintels to be cut out and some stone above them to be removed to allow the substantial new L-shaped galvanised steel angles to be inserted. The internal wall faces were then rebuilt and repointed.

The reinstatement of some sections of the lost brickwork of the lower walling of the calciner bed was undertaken in order to help to reform its outer skin and to protect critical detail of the low remains of the circular calcining bed from any foot-induced erosion of the heat-affected mortars backing it and the resultant exposure of the hearth brickwork to destabilisation and damage. The bricks making up the lowest courses of the lower circular calcining hearth were re-set where they were found to be loose – wherever possible at least two courses were reinstated to allow for the resurfacing of the hearth bed concrete where it had become badly eroded (Fig 69). This did not prove possible at the eastern and western sides of the hearth – to the west, remediating the partial collapse of the brick power vault running beneath the hearth would have required a substantial amount of preliminary rebuilding of this feature, whilst to the east large portions of the material making up the core of the hearth base had been lost. As a result, two long arcs of brickwork were reconstructed – these being felt sufficient to indicate the original plan of the hearth. Minor repairs were made in recovered stone, brick and lime concrete to the outer edges of the calciner bed as these areas were felt to be vulnerable to foot erosion.

In order to protect the underlying power vault from the effects of further water penetration damage, a specialised concrete screed (Fosroc Paverok) was laid over the original eroded brickwork calciner bed once this had been cleaned of loose material, significant hollows in it had been backfilled with lime concrete and the whole surface of the bed treated with Fosroc Nitobond EP as a primer (Figs 71 – 73). The surface of the new screed was feathered off at its junction with the discharge casting on the eastern side of the calciner bed, whilst to the west where damage to the underlying brick power vault had occurred, the screed was cast up against temporary formwork.

The upper course of brickwork on the small furnace adjoining the calciner hearth was rebuilt to strengthen this structure, its badly corroded steel bracing was cut back to remove sections of sharp metal which might cause injuries to visitors and the rusty furnace door surround was given much-needed support by the installation of a galvanised steel prop (Figs 8 & 9).

The concrete first floor walkway along which the tin concentrate had been brought to the calciner feed hopper had originally been supported off four vertically set RSJs (these being braced by one horizontally set beam), by the brickwork of the eastern side of the calciner superstructure, and by horizontally-set re-used bridge section tramrails built into the western wall of the dust chambers. However the demolition of the eastern wall of the calciner and advanced corrosion of the RSJs had left the walkway slab supported solely by the cantilevered rails, some of which were set into the dust chamber walls by only a small amount. In order to support the slab, the rusted out remains of the original RSJs were cut away and a new galvanised steelwork frame was constructed to support the outer western side of the walkway slab (Fig 69). A powder coated galvanised steel grille was fixed into the original south wall doorway opening to prevent access onto the walkway, given the unprotected drops from it.

Given that lightning strikes had badly damaged a pair of mine chimneys in West Penwith in recent years (at Cape Cornwall and Wheal Drea), it was decided to install lightning protection to the short chimney serving the Merton Furnace at North Boscaswell. A copper ring was bonded to the upper face of the chimney stonework once this had been inspected and found not to require repointing and its twin earthing tapes were clipped down the interior of the chimney. A locked galvanised steel gate was installed across the chimney opening at its base to prevent the theft of the exposed section of the tapes. Following shallow (300mm to 500mm deep) trenching along the eastern face of the walkway wall adjacent to the western side of the dust chambers, the earthing tape was emplaced along this line; the temporarily removed geotextile and compacted A803 (installed in 2015 over ground contaminated by arsenic soot) were reinstated, and a 1.4m wide and a 0.8m deep, 1.4m wide trench to contain the earth cable and earth mats was extended 10m westwards from the end of the wall (Fig 27). Copper earth grids bolted to the tape were laid in the base of this trench, which was then backfilled and compacted prior to resistance testing via a tail clipped to the tape and coming to surface within an inspection box next to the dust chamber wall. As a result of the high moisture-retaining capability of the soil used to backfill the trench, an excellent resistance reading was obtained.

The cable for an electric fence power lead required by the NT to allow the surrounding croftland to be grazed by stock was laid in the section of the trench running alongside the dust chamber wall and extending 4m to the west in the main excavation was installed at the same time and terminated at surface for future connection. This would allow the electric fence unit to be securely contained behind the galvanised steel grille blocking off the opening at the base of the chimney. The grille fixings were modified to incorporate hinges and padlocks at the request of the NT to allow the interior of the chimney to be accessed so that the fence power unit can be maintained.

6.2.2 The tin floors, external buddle and the building to their east.

This formerly roofed building at the foot of the dressing floor complex adjoins the Merton Calciner on its eastern side, and was the area where, following calcination to remove arsenic, the black tin concentrated in the mill upslope was cooled, washed to remove hydrated iron liberated by the roasting process, buddled and the high grade material was kieved to effect its final concentration before being dried and bagged for sale. Sub-prime products deriving from these processes were laundered to one of a pair of settling tanks to the north of the building and thence to a further buddle for re-concentration. Lower grade material separated out at this stage was run off into an adjoining settling tank. The high grade products from buddling would have been kieved, whilst the lower grade material was laundered to the second settling tank for further concentration. Sulphide-rich wash water drained from the buddles was transferred to a final set of four settling tanks where it was mixed with scrap iron to recover the dissolved copper released by calcining using the precipitation process. All waste water was drained away downslope, whilst material from which no further tin could be economically recovered was disposed of on the adjoining hillslope. It seems likely from this evidence that the tin floors were set up to produce two grades of concentrate, as well as a precipitated copper by-product.

The first works to be carried out here in 2016 consisted of the reconstruction of part of the upper central section of the southern wall of the tin floor building, this being achieved using dislodged masonry found adjacent to the wall in 2015 and stockpiled for reuse. Whilst the rebuilding was carried out using a 2.5:1 lime based mix, sections of failed pointing on both wall faces were repointed using a cementitious mortar in a style which would match the remainder of the wall (Fig 54). The wall head was left ragged; its joints were repointed using a lime mix to falls which would ensure that water would run off and the wall core could breathe through its head joints.

The large conical-centred buddle on this floor had received some damage to the engineering bricks which formed its upper edge; its rendered cement facings had also been damaged by bramble root infiltration through cracks along bedding joints. The damaged bricks were cut out and the roots chased back into the floor construction to remove them, together with loose soil. Replacement engineering bricks were sourced from a stockpile on site (these bricks having been salvaged during the 2015 works programme) and were re-bedded in a cementitious mortar. Where found to be damaged, the cement render to the internal face of the buddle was made good in matching material (Figs 52 – 53).

Elsewhere within this area of the site, a small number of badly cracked sections of concrete flooring were cut out and replaced, timber linings were reinstated in the larger drainage channels and galvanised grilles set over these and over a pair of sumps to remove trip hazards (Fig 47).

Once the ivy cover on the walls of the kieving shed at the eastern end of the tin floors had been removed it was found that the mass concrete used in its construction was very hard, incorporating abundant clinker as an aggregate (this would have acted as a pozzolan). Some general surface cracking was present over much of the rendered faces, and several movement cracks were present along original construction joints. Rather than demolish potentially unstable sections of walling (as had originally been proposed), it was decided to install a relatively thin concrete cap along the whole of the wall head to prevent any further water penetration and to help to infill a small number of cracks. The cap incorporated the reconstructed slots for three original 50mm wide roof timbers, evidence for which had been revealed when the covering ivy on the head of the original wall was removed.

To the north of the tin floors, the ground around the external buddle was machine trenched down around its external brick and stone walls, the trench was cleaned by hand down to the top of the rab and any remaining bracken rhizomes within the masonry of the buddle walling were treated with Glyphosate (Fig 75). A woven geotextile fabric barrier was then installed in the trench to prevent future root infiltration, something which had, in the past, caused very significant damage to the rendered inner facing of this structure (Fig 76). The trench between the folded fabric was backfilled with granular material, which was covered to surface on its southern side by A803 mixed size granular material to match the path constructed along the adjacent northern face of the dust chambers and with excavated soil from which bramble roots and bracken rhizomes had been removed by hand around the remainder of its circuit. Bramble roots and bracken rhizomes were dug out from cracked sections of the inner face of the structure, together with any other organic material, the joints were re-packed with bedding mortar and the inner face of the buddle brickwork was re-pointed in a cement mortar to match the existing. Minor repairs were also undertaken to the central cone of the buddle where this had become damaged by cracking and subsequent root infiltration. The paired concrete sockets for the buddle’s original timber superstructure were revealed during these works and were left exposed on its completion.

Repairs were also undertaken to the mass concrete settling and precipitation tanks to the north of the tin floors (Fig 77). In the case of the latter this entailed the removal of some substantial gorse and bramble roots and the re-forming of major sections of the badly damaged (and in some cases lost) sections of its subdividing rubble and concrete walls. There were reconstructed on a like for like basis, then skimmed over with a cement mortar to reform their heads and faces, matching the originals. Only minor repairs were required to the heads of the walls of the adjacent settling tanks.

The elongated revetting wall stretching to the east of the tin floors was cleared of vegetation on its northern side, and scrub and infiltrating roots were removed from its head and face, ground levels were reduced to an extent on its southern side (this material represented slimes and soil cleared out of the settling tanks which had been spread in this area during 2015), the joints were repointed in cement mortar where required and its capping stones were re-bedded where they were found to be loose (Fig 78). Two sections of broken wall end were partially rebuilt and repointed to prevent any further collapse. At the wall’s eastern end, the small building which might have formed the site’s powder house was cleared of rubble and vegetation, minor repairs undertaken where destabilising wall collapses had occurred, its wall top stones were reset and its walls were repointed where required using a cement-based mortar to match the original (Figs 79 – 80).

No diagnostic information relating to the original use of this building was discovered during this work. Its small size and relatively remote location might suggest that it had originally been the mine’s explosives store (no other building of appropriate size is mapped at North Boscaswell), though it is somewhat remote from the mine's principal shaft (where the explosives would have been taken underground), and it appears not to have been internally subdivided, as would be expected for a building of this type dating from the early 20th century, when regulations required explosives and detonators to be stored separately. Alternatively, this might have been a store for finished tin ready for sale, though it would have been rather a small building to have fulfilled this function, given the size of the dressing floors upslope and their likely intended scale of output. The work on this building did not include full excavation of its floor, which might provide the detail which would allow a better understanding of its original function.

6.2.3 The dressing floors

The dressing floors incorporated the equipment used to crush and size the ore from Trease and Treweek's Shafts using the rock-breaker in the ore bin and the Californian stamps sited on the floors, classify it into three grain sizes, and concentrate it using a Record Table, a number of Pinder Tables and either two or four belt vanners, a pulveriser being utilised to reduce over-sized material for re-processing after initial concentration. The mill produced several grades of concentrate for final processing as well as a number of waste products, the concentrates subsequently being carted to the Merton Furnace and tin floors for calcination and final concentration by buddling and kieving prior to sale.

Although in general the components making up the dressing floors were found to be in fairly good condition, some of its components had been constructed of very poor quality concrete which had, as a result, degraded badly, particularly a number of the Pinder Table mountings and some of the power transfer plinths near the site of the mill engine (Fig 12). In other areas incorporated timber components had rotted away, either completely or almost so, in particular the basal timbers (the mud cills) which had supported the Californian Stamps framing, the anvil supports which cushioned the shock of the falling stamps (Fig 7) and those which had supported the vanning tables. The larger drainage culverts running across the floors and a sump on the lower floor were considered to be trip hazards, as were some upstanding iron brackets and mounting bolts, Galvanised steel grilles were fitted over the deeper drainage channels and sumps to mitigate these ground level trip hazards.

The central part of the mill incorporated a number of masonry walls, some of which had become significantly destabilised by the infiltration of woody gorse growth, whilst sections of thin concrete wall capping had become significantly fractured (or in some areas completely destroyed) allowing rain to get into wall cores, and scrub vegetation to become established in them (Fig 42). A very badly damaged concrete-faced rubble plinth at the eastern end of the lowest level of the dressing floors adjacent to the elongated settling strips forming its edge was to be cleared of rubble and vegetation, backfilled and reformed in concrete. Similar though less extensive repairs were to be undertaken to an undercut area of at the northern edge of the middle section of the tin floors where local children have partly demolished a wall face and had excavated out the loose fills below the mill floor (Fig 38).

In early March, the contractors cleared out the rubble from the interior of the remains of the large plinth on the lowest section of the dressing floors, backfilled it with clean stone and blockwork recovered from the site mixed with concrete and then re-formed the original form of the plinth within temporary shuttering (Fig 40). The void beneath the machine base just to the south which had been excavated by local children was backfilled with loose rock, faced off in reclaimed masonry, pointed, and grouted through original openings on the top surface of the overlying floors (Fig 43).

The concrete making up three of the Pinder Table mountings on the middle floor of the mill and one on the lower floor was evidently of poor composition, resulting in them having disintegrated to varying degrees (see Fig 12). These were shuttered up with shaped formwork and re-rendered to reinstate their original forms and to prevent any further deterioration (Figs 34 - 35).

The slots cut into the lowest mill floor to take the mountings for the vanning tables installed to substitute for the buddle originally used for final concentration were backfilled with timber sleepers to surface; the edges of the pits were pointed back flush to the surrounding floor surface to prevent water ingress damaging the timbers (Fig 45).

The clearance of the woody vegetation (mostly gorse) which had largely covered and had partly rooted into the walling defining the perimeter of the lowest section of the dressing floor (containing the final Pinder Table, the buddle and the replacement vanning tables) revealed the masonry making up this structure to be in very poor condition, indeed in places there appeared to have been little actual stonework, the cement rendering which had originally faced these walls having been formed up against stony fines or soil, particularly at the base of the walling in some sections (Fig 42). Long-standing root infiltration had also done considerable damage to some lengths of the wall, dislodging some of the stones it incorporated and breaking mortar bonded joints. It is possible that this wall had originally been constructed up against an originally raised ground level to the west, though during the construction of a pair of small tanks adjoining the wall, the ground levels to the west of the mill were reduced, and the exposed western face of the walling was rendered over. Although rubble was removed from the tanks revealing the heads of their concrete walls, their fills were not emptied.

Substantial sections of these walls were cleared of vegetation roots and rebuilt in salvaged masonry set in a fairly dry mortar mix and then repointed to match the originals. The original cast concrete capping to these walls was not reinstated in 2016, though a consistent wall height was achieved through localised rebuilding in salvaged granite (Fig 39). Patch repairs were undertaken to some of the mill walls upslope, there being insufficient funds in the 2016 budget to allow for the full repair of all of the walling on the site. A further round of works will be required if all of the walling on the site is to be appropriately stabilised and capable of surviving in the long term.

To the east of the lowest section of the mill, the small rubble-filled pair of settling tanks had proved too fragile to clear by machine in 2015, and had been left as found at that time. Hand clearance of their fills in 2016 showed these to consist of clayey organic soil into which woody scrub had rooted. A narrow sub-dividing brick wall was found within the eastern tank during its emptying. The former function of these tanks is unclear, though they are likely to have collected run-off from the adjacent mill floor in an attempt to recover any very fine tin suspended in the waste water from the tabling and vanning processes which would otherwise have been lost.

Adjacent to the Pinder Table floor in the mill, the walls had evidently been formed of sheet steel cladding on timber studwork, this being carried down to the ground surface and there is abundant evidence that the relatively thin concrete of the mill floor had been cast onto levelled rubble and soil once the wall sheeting was already in place, the edges of the floor slab retaining the marks of corrugated iron sheets (Fig 36). The removal of the wall cladding had exposed the ground beneath the eastern and western edges of the floor slab, resulting in the partial erosion of some of the material making it up, resulting in partial undercutting of the thin and inherently rather fragile concrete slab. In order to underpin the slab, its underlying fill material was partly cut back to allow concrete to be packed into the voids, both supporting the edges of the floor slab and preventing any further erosion (Fig 37).

At the top end of the mill at the eastern edge of the mill boiler house, an amorphous hollowed feature in the floor which had been partially excavated in 2015 was backfilled to surface with granular material to remove a trip hazard. The slots for a further pair of machine mountings on the lower edge of the middle mill floor were similarly treated.

The final works to be undertaken within the mill consisted of the reinstatement of the central pair of 'mud cill' timbers which had supported the stamps, as well as the vertically-set timbers which had supported the cast iron stamps anvils (Fig 6). These features had survived, but had been largely reduced to a mass of rotten timber which, following its exposure, rapidly crumbled away (Fig 7). The excavation of the pits for the anvil supports showed these timbers to originally have been over two metres in length, the lower portions of these surviving *in situ* (Fig 48). The pits were cleaned of all rotten wood and partly backfilled with coarse gravel, on top of which were set 1.2m long sections of replacement treated timber, these being set in the pits so that 0.3m of their top sections protruded above floor level (Fig 49). Hidden fixings into the pit walls and to one another were used to prevent any risk of subsequent theft of the timbers. The replacement mud cills were narrower than the originals, as timbers of the original large size would have to have been cut to order. The 100mm gap left next to the new timbers in the original floor slots was infilled with mortar to prevent water accumulating in them. A colourant was added to this mortar to distinguish the new work from the old (Fig 50).

The open drainage channels on the middle and lower floors of the mill had been identified as potential trip hazards to visitors, as had a drop between two of the mill engine loadings and a sump on the lower floor. Galvanised steel gratings were fixed over these onto angled metal strips, these being fixed down onto strips of timber lining the sides of the channels (Fig 46).

Two drains run beneath the former roadway between the dressing floors and the tin floors, coming to surface at its lower edge to discharge into shallow drainage channels. Rubble had been dumped into one of these during the contract, and an effort was made to clear this out using a swing shovel. As this was seen to dislodge some of the stone facing of the channel sides, this was halted. The remainder of the clearance was undertaken by hand and the dislodged stonework was reinstated.

6.2.4 The field barn

Trease field barn (Figs 13 -15, 28 - 32) was the first structure to be tackled in January 2016 and work continued here through to the end of the works programme in early May 2016. The barn, which was contemporary with the early C19th Trease smallholders' farmstead, had become disused more than two decades ago. Owing to the almost complete collapse of its slate roof covering, the tenant farmer on whose land it lies had blocked in all of its doors and windows to prevent children using it as a den and placing themselves at risk of accidents, whilst repointing in a cementitious mortar had been carried out to the wall corners at some time in the past, presumably in order to stabilise the building. Although originally designed to provide threshing and feed storage facilities on its first floor and an animal shelter on its ground floor, internal evidence suggests that the first floor timberwork had probably been lost many decades ago. The paired winnowing doorways on the first floor had been blocked in at the same time, though small windows had been left at their heads. The barn this period had been solely used as an animal shelter.

The presence of the paired doors in the northern and southern elevations on the upper floor indicates that this floor was used for threshing, the opening of both doors creating a through draught which would enable the chaff to be separated from the grain by winnowing. The presence of such a feature also indicates that at least some of the fields at Trease were formerly in arable, this being substantiated by the entries for this farmstead in the apportionment to the *circa* 1840 St. Just Tithe Map.

The stripping of the ivy which covered most of its southern wall (and the adjoining parts of the flanking eastern and western walls) revealed the first floor doorway at the top of the ramp/steps on this elevation (Fig 13). As had been expected, the doorway had been blocked in with masonry, but a 0.8m high x 0.77m wide window had evidently been maintained through its western corner at its head, matching that on the northern elevation. For some time after the upper doorway had been infilled, this small window had been maintained as an opening, but it had subsequently been blocked in with stones set in a roughly-applied cementitious mortar applied from the outside face of the building, like that on the northern elevation. A further small window near the wall head was found to the east of this, matching that on the northern elevation of the barn in both position and size.

The access ramp was found to have lost some of its facings as well any original step treads which might originally have been present (Fig 30). As there were no proposals to reinstate the lost first floor or to reopen the blocked upper southern doorway, the remains of the ramp were cleared of rubble and vegetation and some rebuilding was undertaken to stabilise its masonry remains. The decision was made to remove the cement pointing to the wall corners, as this had deteriorated, partly detaching from the faces of the stonework, and it had proved difficult to get the new lime pointing on the abutting wall joints to make a good seal against it. The removed cement pointing was replaced using a lime mortar (Figs 30 – 31).

Once the breezeblock infill to the ground floor doorway on the northern side of the barn had been removed, it was possible to inspect the interior of the building (Fig 29). The timberwork of the ground floor had clearly been lost long ago, leaving no remains, and only the remnants of some of the roof trusses and a small proportion of the original slate roof covering were found on the floor, together with some organic material, a number of plastic fertiliser sacks and a few pieces of agricultural ironwork. The internal elevations seem never to have been pointed, almost all joints being infilled to surface with rab. Inspection of the lintels over the northern upper floor windows suggested that they were suffering from rot and woodworm and would require replacement in oak. Those over the ground and upper floor doorway, as well as that over the small ground floor eastern window were found to be in much better condition, and were judged capable of retention, though the crudely-constructed blockwork infill to this eastern opening was identified as requiring removal. The stone infill to the outer face was dismantled and rebuilt to prevent access to the interior of the building. The stone infill to the upper windows and doorway was to be retained, as this was of some historical significance, and additionally provided support to the reveals and lintels framing the openings. Clearance of the rubble and rubbish from the floor revealed a roughly cobbled floor with a 0.8m wide unsurfaced shallow drainage channel against the northern wall of the building. The floor sloped noticeably from east to west, though no drain opening through the wall was found at the downslope end of this channel. Inside the barn, the lowest 500m of the wall joints were repointed in lime mortar, as these were notably open.

It had originally been intended to utilise salvaged roofing slates to cap the wall heads, to ensure that rain water was shed off them and did not make its way into the wall cores, but on examination, the width of the walling did not make this a viable approach, as this would have required the installation of several courses of slate. Instead, the top course of the inner wall facing stones was reinstated where lost and re-set where present, and a flaunched cap was formed to throw the water towards the outer faces of the walls. The gable wall heads were cleared of remnant slates, laths and purlins (most of the woodwork being worm-eaten) and the joint beds were repointed. Given that the joint fills on the internal faces of the gable heads had become significantly eroded through exposure to the weather once the roof had been lost, these were repointed in lime mortar down to wall plate level.

The former ramp to the upper floor door had been covered with ivy, brambles and gorse at the outset of the project, but this feature could clearly be seen to be in poor condition (Fig 30). Removal of the vegetation showed that any original stone treads had been robbed out and that the rubble stonework forming the core of the structure had partially collapsed, exhibiting several substantial voids, as well as displaced facing stonework. It was decided to reform several sections of the ramp facing to make the structure more stable, to lay down a root-proof geotextile material on its upper surface once this had been backfilled and consolidated and to cover this with A803 mixed size granular material (Fig 31).

The final works to the barn consisted of the installation of a lockable powder-coated galvanised steel gate to the ground floor doorway so that future access to the building could be controlled (Fig 32).

6.2.5 Mine shafts and openworks

The stone hedges on two shafts had been reconstructed by Kernow Maintenance Services in 2015 prior to being securely fenced around with barbed wire (Figs 22 – 24). That not far to the north of Trease Shaft on the line of the lode outcrop was found to be backfilled to surface with rubbish and enclosed within a poorly constructed mine waste hedge topped with the remains of a wire fence on old drill steels (this fence had almost certainly been put up by Geevor Mine when they were exploiting the underlying lodes between the 1960s and the late 1980s). The shaft hedge was rebuilt where judged to be in poor condition and externally fenced with barbed wire (Fig 24). The shaft adjoining the eastern site boundary on the Boscaswell Downs Adit was found to be open, considerable volumes of water running through its base at adit level. This hedge was felt to be sited too close to the open shaft it enclosed, requiring reconstruction slightly further away from it; a barbed wire fence on timber posts was added as a secondary safety barrier (Fig 23).

Two further shafts were fenced in the same contract – one being a blocked possible example adjacent to the cliffland boundary walling, the other being represented by a large mound of vegetated spoil in the enclosed fields. The first was double fenced to provide a suitable safety barrier, whilst the second, whose fills had reportedly subsided in recent years, was fenced around at the base of its spoil dump (Fig 22). In addition, the section of backfilled openwork running from the foot of the Trease Shaft spoil dump northwards towards the coast was fenced on both sides as far as the point where it was crossed by an informal path around the open area of croftland (Fig 25). Some limited subsidence could be seen to have taken place within the fills of these outcrop workings just to the north of the adjacent Trease Shaft dump. These openworks are likely to have formerly continued through the enclosed land to the north of the area of croft, though as no indications of them can be seen in these fields, they are assumed to have been backfilled prior to the 19th century. Although no recent episodes of subsidence have been reported within this northern section of the property, the likely outcrop of the lode here should be periodically monitored for any signs of such activity.

The principal shaft on the site – Trease (New) Shaft is set at the centre of a rocky spoil mound within a substantial mass concrete plinth which formerly sited the mine's production headgear and incorporated primary ore bin. These features had been removed, and the shaft had been covered over with railway sleepers (Figs 16 – 17). This probably took place during the period from the 1960s to the late 1980s when Geevor Mine was working the underlying Boscaswell Downs lodes (a mass concrete survey station of a type constructed by Geevor Mine at various locations within the surrounding area is sited close to the shaft). Between the 1960s and 1990, the shaft and underlying workings would have been drained by Geevor's pumps, but the shaft is now full of water to within 10m from surface, suggesting that its associated shallow drainage adit has collapsed and become blocked. This may have implications for ground stability downslope, given the ground pressure which may be exerted via shallow workings connecting to the shaft by this head of water. Water issuing from the ground downslope during excavation associated with safety works to a section of the backfilled shallow workings on the lode is assumed to be that filling workings between this point and Trease Shaft, and almost certainly the shallow workings to the south of Trease Shaft. Water also comes to surface in the field downslope which contains the now-fenced shaft mound.

Clearance of the gorse which covered much of the shaft plat (the levelled area around the shaft opening on which the headgear was erected) and the lifting of the sleepers revealed that the concrete slab framing the shaft opening was undercut on all sides to approximately one metre. Indications of narrow backfilled outcrop workings were also noted in the southern face of the shaft not far from surface. In mid-May the timber sleepers covering the shaft were removed, revealing detail of the interior of the upper section of the shaft. The concrete headframe support slab was found to be 200mm deep, but had been extended down the shaft for 2m as a collar which had originally been timber lined. Two sets of paired tramrails which had been used as buntons (skip guides) within the shaft during its last period of operation were still in place, though the stull (cross timber) to which they had been attached at 5m from surface had become detached at one end, moving them out of their original positions. These clearly indicated that twin (counterbalanced) skips had been used in this shaft. There were no surviving traces of a ladderway. A small diameter steel compressed air pipe ran down the north-western corner of the shaft. Small, early shallow workings could also be seen at about 3m from surface and about 6m from surface within the shaft at both its northern and southern ends. The shaft appeared to be almost completely blocked with timber debris at about 10m from surface, below which standing water could be seen. The timber appears to have been original early 20th century work, and there were no indications that the shaft had been rehabilitated for re-use by Geevor during the 1960s-1980s.

A two-section galvanised steel grille had been designed and constructed by local metal fabricator Jerry Harvey Engineering to not only cover the shaft opening, but to extend 1m back from this to ensure that it could be secured to sections of concrete founded on bedrock. This was fitted once the timber shaft cap had been removed, and was bolted down into the concrete slab using studwork set into Chemfix filled holed drilled into it (Figs 84-86).

The northern end of the fenced section of backfilled openworks terminated at a rough trackway which provides access around the site (Fig 25). This is one of two points at which grazing stock can move from the eastern to the western section of the site and will be occasionally required as a vehicle track by the NT Ranger and by the tenant farmer. Given that at least one section of the backfilled openworks nearby is currently displaying some signs of subsidence, it was recognised that it would be necessary to secure the fills at this point against collapse.

Research undertaken by the CAU Archaeologist identified a geogrid product which would be sufficiently robust to carry any expected loads should such any subsidence collapse occur (Tensar TriAx TX170). The soil and overburden was excavated down to an average of 400mm on either side of the 1.25m wide backfilled openwork (600mm on the uphill side, 300mm on the downslope side) to a distance of 3.25m from the edges of the openwork at rab level and the loose stony fills of the mine working were partially excavated. At this point during the work copious amounts of water began to issue from the uphill side of the openwork, almost certainly draining from Trease Shaft and the interconnecting shallow workings. Stony material recovered from the excavation was used to backfill the excavated section of the openwork to allow it to continue to drain, the geogrid was laid in the levelled trenched area (Fig 26) and compacted arisings were replaced over it to restore the ground levels, soil being added first, all stones which might potentially damage the geogrid being picked out by hand during the process. The finished ground level was left raised slightly on the downslope side of the trench and lowered slightly on the uphill side to ensure that there was at least 400mm of compacted cover over the whole of the geogrid to pin it in place.

This area along the strike of the shallow workings will require periodic inspection by the NT Ranger to determine whether any future subsidence has taken place, as will the known areas of outcrop workings between the mine service buildings and the boundary wall at the southern edge of the site, as well as the projected line of the outcrop as far as the cliff boundary to the north. Should indications of any collapse be observed, a more permanent approach to the closure of the shallow mine workings will be required.

One poorly documented shaft identified from an Abandoned Mine Plan by Cornwall Consultants (Bennett 2013) could not be located on site. It appears to have been a trial shaft around 30m deep, and it is uncertain which lode it was sunk on, or by whom. The mapping, described as ‘schematic, undated and of poor quality’, appeared to place the shaft near the central point of the eastern boundary, somewhere near the field barn. No evidence for the site of the shaft could be found within the adjoining area of croftland and it was concluded that the only possible remaining location was within one of the small enclosures which extended to the north-east of the field barn and whose dividing walls had been removed during the 20th century.

A re-examination of the 1840 St. Just Tithe Map and its apportionment showed that whilst the two small enclosures nearest the field barn were described as having been in arable (probably reflecting their use as gardens), the use of the north-easternmost and smallest was not described and the enclosure was of a rather unusual shape, being a truncated pyramid in plan, field survey showing that it had a notably curving section on its north-eastern side which may reflect the presence of a shaft nearby within the enclosure. This area is now densely ingrown with blackthorn and thus inaccessible, but no indications of the relatively substantial mine waste dump which would have accompanied the documented shaft could be seen. It was concluded that, if this were the site of the missing mineshaft, it is likely to have been backfilled using the material available from the nearby spoil dump. The area might subsequently have been left to scrub in, or might have been used as a pig run during the 19th century when these enclosures were in active use. There are no indications of a shaft here on either the 1878 or 1907 OS 25" mapping, and it was concluded that if this were the site of the missing shaft, it is likely to have been backfilled during the early decades of the 19th century when nearby Trease Farm was being established. This area was free of scrub in 1973 (Fig 4), and there were no indications of the shaft showing in this area at the time.

The local NT Ranger intends setting up a post and wire fence around the likely area of the shaft as a safety precaution, though in practice the dense blackthorn scrub growth currently infilling the enclosure effectively bars any access into this area.

6.2.6 Other site clearance activities

Much of the gorse and bracken within the area site surrounding the above ground remains of North Boscaswell Mine were cut by the National Trust countryside staff using a tractor-mounted flail prior to the 2015 conservation works. Substantial bracken regrowth took place subsequently and an enlarged area was re-cut during late autumn 2015 by the National Trust, the bracken being sprayed with Azulox by licenced contractors to prevent regrowth.

A number of earthwork features were revealed as a result, including two linear features running away from the foot of the Trease Shaft dump (Fig 18), heading to the north-west and north-east. That heading north-east is accompanied by a relatively substantial earth bank on its downslope side, runs across the slope to the south-eastern corner of the western reservoir and then continues downslope as a poorly-defined open channel parallel to the western side of the mill building. The western section of this feature appears to continue the line of the northern bank of the previously-recorded earthwork enclosure near the western boundary of the croftland, suggesting that this small field system had previously been more extensive, though had been cut through when the winding engine house was constructed. It is possible that part of this bank and ditch was re-utilised as a channel taking water from Trease Shaft to the western reservoir, if pumped water was used to fill this. The eastern channel has the appearance of an overflow drain, and fades out on the slope to the north. The eastern reservoir (Fig 19) seems likely to have been filled by a leat running northwards from a long-established pond close to Pendeen (The Leats) via a triangular header pond next to the southern entrance to the site. The possible use of different water sources to fill the two reservoirs might have affected the quality of the water in them, and determined whether they were used to feed engine boilers (which required a clean supply) or were used on the dressing floors.

Two drains were found issuing from the foot of the mill, running downslope north-east towards a point just to the east of the eastern end of the tin floors where they combined. These would have carried the waste water from the sump on the lowest floor of the mill, and the overflow from the elongated settling tanks on its eastern side; both incorporated long stone-capped culverts in the area between the foot of the dressing floors and the tin floors to the north, suggesting that this area formerly incorporated one of the mine roadways. It is assumed that this waste water was run off into the north-eastern corner of the area of croft as no further extension to this occasionally stone-faced outflow channel could be found to the east of the tin floors.

A series of further, rather amorphous earthworks were revealed in the area upslope from the head of the dressing floors; what these might represent could not be identified, though they might include a small number of backfilled prospecting pits as well as a linear feature with a low stone revetment on its downslope side which is likely to have been a mine service track. An approximately rectangular shallowly-hollowed area to the east of the Trease spoil dump appears to coincide with the location of one of the small buildings depicted on the 1840 Tithe Map. The shapes of the dumps of soil produced during the excavation into the hillside of the eastern and western reservoirs, the winding engine house, the mill and the tin floors were also more clearly defined by this work, and their associations with nearby structures are now more readily appreciable to the site visitor. A section of a former mine access roadway running south-eastwards from the gateway on the site entrance track to the eastern service building at the top end of the site was cleared of scrub, as was part of a curving trackway leading towards the coal bin at the head of the mill. The locations of most of these and other earthwork features have been accurately located by the drone-flown photographic survey commissioned by the NT in 2016 (Fig 83).

During January 2016 the National Trust Long Term Volunteers based at Botallack undertook the clearance of scrub vegetation in and around the service buildings at the southern end of the North Boscaswell site and within the winding engine house to the west of Trease Shaft using a combination of hand tools and brush cutters. Little in the way of diagnostic detail was revealed as a result of this work, though it has made this part of the site more accessible to visitors, and has opened up views between this part of the site and the other areas downslope. This work will also make it possible to undertake the future conservation of the masonry structures of the western pair of buildings and the propping of the rather precarious surviving mass concrete slab wall of the eastern building, should funds for this work become available.

The further removal of gorse and brambles in the area between Trease Shaft and the head of the mill in late January 2016 uncovered the majority of the concreted stone bases which had footed the slightly angled timbers forming the ore tramway supports (Fig 20). Most of these socket pads were spaced 4.0m apart along the line of the tramway and 2.0m apart across its width, these dimensions suggesting that most of the tramway was single track (though six wagons are documented to have been used by the mine). A widened section of the stone faced tramway embankment immediately to the south of Trease Shaft is likely to represent a passing point, whilst a second may have been at the head of the mill, where the concrete supports for the trestles are sufficiently wide to have carried two lines of narrow gauge rails. The concrete supports at the point where the tramway turned from the east to the north and headed towards the mill were found to be of more massive construction and set slightly closer together. The absence of any evidence for such supports in the area immediately upslope from the head of the mill suggested that a mine roadway ran in from the east at this point, most probably to access the area next to the coal bin. The tramway is likely to have been carried on a short bridge over the roadway in this area, its timber trestles being documented as having been approximately three metres high at the point where they approached the tipping point into the top of the tall ore bin at the head of the mill.

During the period of the conservation works contract, the local NT Ranger set out the line of the electric stock fence which will ensure that the mining remains at the heart of the site will not be damaged by the grazing stock which it is intended to reintroduce to the site later in 2016. Replacement granite gateposts and gates are also to be installed to allow individual fields within the field system to the north and north-east to be either closed off or opened up to stock, as required.

Further areas of woody gorse remain on site, and although these provide some birds' nesting habitat, they should ideally be removed in the future, together with, in places substantial areas of brambles and thorn which have grown in from the site boundaries. Woody scrub and other growth within walls making up or close to the North Boscaswell mill which were not conserved during either 2015 or 2016 also require either spot treatment with herbicides or at a minimum, annual maintenance by the NT Ranger team to prevent any future degradation of these structures or future spread of obscuring scrub vegetation.

7 Significance

The Trease property is, in many ways, characteristic of many of the other farm holdings which are set along the coastline between Pendeen and St. Just, its fields containing evidence for occupation from late prehistory to the present day. A short-lived miners' smallholding was established here during the early 19th century, and Trease sites evidence for mining operations typical of those used to work the St. Just lodes between the 16th and 20th centuries. The incorporation of this holding into the wider West Penwith National Trust holding has been an important step, both securing the appropriate future management of the Trease property but also further strengthening the overall NT West Cornwall property portfolio; it is also an important addition to the virtually contiguous group of St. Just coastal properties within which mining has been an important factor in the development of their landscapes.

As identified in the 2014 assessment, however, Trease is particularly important because of its surviving Merton Furnace and adjacent dressing mill and tin floor which were constructed during a short-lived early 20th century working of North Boscaswell Mine.

Within Britain, Merton furnaces are recorded as having been utilised in picric acid production in Avonmouth and in South Wales for the roasting of zinc blende; the only recorded examples used in the dressing of tin and copper ores were at North Boscaswell, at Tresavean near Lanner and at Gwithian Streamworks. Worldwide, they were utilised in relatively small numbers for ore roasting at mines working tin, copper, zinc and gold deposits in Queensland and Tasmania, Australia, in South Africa, in California and in Canada. Very limited surviving remains associated with Merton Furnaces are recorded at Tresavean and Gwithian, and at the Sundown and Mount Hepburn mines in Australia (see Section 9). The example at North Boscaswell is the best preserved of the very small number which survive anywhere in the world.

The work commissioned by the National Trust in 2015 and 2016 to reveal, decontaminate and conserve the remains of this structure has, therefore, been particularly important, as this example appears very likely to be the best-preserved example anywhere in the world and is thus of international significance. The other mine remains are regionally and nationally important for several reasons: firstly, they provide the only surviving physical evidence anywhere in Cornwall for the use of some unusual ore dressing equipment; secondly, the equipment used here was fairly well documented, though it is clear from the fieldwork that there are some differences between what was planned and what was constructed, and thirdly, fairly unusually within Cornwall the field remains represent a short-lived single phase early 20th century mine.

Taken together, the works undertaken by the National Trust at Trease in 2015 and 2016 have opened up, made safe and conserved a site which is both typical of many tenements in the St. Just Mining District, but which contains a very rare monument type – its Merton Calciner.

Now that this site has been cleared of its long-standing scrub cover, it will be capable of being accessed by and interpreted to the visiting public provided that any scrub regrowth is periodically managed. Given the rural character of the site, it is important that the design of any interpretation for this site is sensitively designed and located so as not to be unnecessarily visually intrusive. Whilst much is known about the design and operation of this mine, and whilst it was essentially relatively small-scale and simple in layout, the complete removal of the superstructures of its buildings and of its machinery could make understanding its remains and its modus operandi difficult. Nevertheless, this should be attempted. Most of the information required to achieve this can be drawn from the site survey and historical research which have already been completed, whilst photographs of the interiors of contemporary mill buildings are available.

North Boscaswell Mine should also be placed in its historical and geographical contexts. Within West Penwith, this is a relatedly late and 'modern' mine, akin to others such as Rosevale (1906-14), Trewey Downs (1906-10) and Trevega Bal (1907-15) near Zennor, Worvas Downs (1905-9), Giew (1908-13) and Lelant Consols (1905-11) near St. Ives, New Botallack (1905-14), Porthledden (1908-13), Wheal Bellan in the Cot Valley (several phases of re-opening in the early 20th century including one prior to the Great War), Wheal Diamond near Kelynack (thought likely to date to the first decades of the 20th century), and the first phase of 20th century development at nearby Geevor (reopened 1907) in the St. Just Mining District, all of which also utilised cast concrete as a construction material and which, to a greater or lesser extent, employed electrical rather than steam power.

Ultimately, however, New Boscaswell was a short-lived failure, the victim of a combination of the relatively limited mineralogical resources it exploited, the failure by its management to develop the mine in depth, and the economic and historical events which shortly followed its opening (the Great War and subsequent Great Depression). In this respect it is also typical of the majority of the Cornish mines which were re-tried during the first decade of the 20th century, including almost all of those in West Penwith, Geevor being the only exception given that it alone survived this period and continued to be operated for most of the remainder of the 20th century.

This was not the first time that the Boscaswell lodes had been tried, however, as there is evidence here and in the nearby cliffs and the valley running back to Boscaswell for workings which may date back to the 17th century (or earlier) and which were certainly repeatedly re-tried during the 18th and 19th centuries, at times quite successfully. The underlying lodes were worked by Geevor Mine in the later decades of the 20th century in common with most occurring in the landscape around Pendeen.

Trease also well demonstrates the ways in which farming and mining intermingled within the historic economy of West Penwith, in particularly within the coastal strip running from Pendeen to St. Just, and how these two activities influenced its landscape evolution from the 18th century until the early 20th century. Equally, the underlying lynchetted field system at Trease demonstrates how the West Penwith coastal plain has been farmed since at least the Romano-British period, and probably long before. It is important in telling the story of Trease that this long agricultural history is also mentioned, in particular the period during which Trease, like many other small farms laid out in the cliffland between Pendeen and St. Just during the early decades of the 19th century, was occupied by miner-smallholders.

Arsenic calciners are now rare features of the Cornish mining landscape and are integral components of the Cornish Mining World Heritage Site, recognised as making important contributions to its Outstanding Universal Value. The generally complete Brunton calciners, flues, labyrinths and chimneys at Botallack Mine, at Wheal Busy and in the Tolgus Valley near Redruth, the arsenic calcining complex at Devon Great Consols in the Tamar Valley, the multi-calciner complex at New Consols, Luckett, and the two Brunton calciners at Geevor have been designated as Scheduled Monuments because of their national rarity. Whilst a fair number of Brunton calciners survive in a range of conditions across the mining districts of Cornwall and West Devon, the Merton furnace at North Boscaswell appears to now be unique in Britain.

Finally, and by no means the least important of the significances of the site, North Boscaswell was typical of many West Penwith mines in that its workforce was drawn from the immediate neighbourhood. On more than one occasion over the past couple of years, locally-based contractors have commented that members of their families had worked at North Boscaswell mine, and for that reason there remains a strong sense of local ownership of this site, not in the least linked to the fact that once the financial backers and non-local managers had moved on to seek new opportunities, the former miners and their families continued to live locally. If the opportunities to make a living out of mining had yet again disappeared (as they often had periodically for their forebears), they turned to farming, to the building trade or to other locally-based work. They still walked their dogs on the nearby cliffs, and their children adopted their fathers' abandoned workplaces as their outdoor playgrounds, long before archaeologists began to enthuse about them as significant Cornish heritage sites. Sometimes the local children's interactions with them were a little on the rough side and damage was done, but there can be no doubt that these continuing interactions ensured the retention of a strong sense of local ownership. Sites such as this are still walked by local people on a daily basis, and woe betide anyone who takes cultural possession of such sites without seeking the approval of local people.

8 Recommendations

See Fig 82.

In view of the extreme rarity and demonstrable international significance of the Merton Furnace at North Boscaswell it is recommended that the National Trust makes an application to Historic England for this element of North Boscaswell Mine (and possibly also its related dressing floors) to be added to the Schedule of Ancient Monuments. A successful application would nationally recognise the particular importance of this internationally virtually unique structure, confer on it a high level of protection and make the site potentially eligible for HLF and other grants.

Whilst the 2015 and 2016 conservation works have tackled many of the structural issues affecting the mining features at North Boscaswell, budget limitations inevitably constrained the totality of the work which could be undertaken. The following works remain to be tackled on site, should future funds allow:

High priority

- Remove vegetation, roots and other material from the remaining un-conserved masonry walls associated with the North Boscaswell mill, treat roots with glyphosate, rebuild stonework where required and repoint in lime mortar or reconstruct as dry-laid walling as appropriate.
- Undertake repair and stabilisation works to the mine service buildings and the remains of the winding engine house and associated boiler house.

Medium priority

- Rake out and repoint the remainder of the internal masonry joints within the Trease field barn.
- Undertake minor repairs to the remaining machine plinths within the mill (including those associated with the mill engine) where cement facings or cappings have deteriorated.
- Clear rubble, rubbish and the remaining scrub vegetation from within and immediately surrounding the mill.
- Stabilise the remains of the elevated masonry section of the mine tramway adjacent to Trease Shaft and clear scrub vegetation from the excavated section of the tramway to its south running up to the property boundary.
- Expose and undertake minor repairs to the concrete and stone tramway trestle supports between the mill and Trease Shaft.
- Install replacement steps within the mill where these have been lost to facilitate visitor circulation. There are two principal locations where this is required – adjacent to the mill boiler house where one step has been lost and between the boiler house/engine level at the head of the mill and the stamps floor adjacent to the lowest tramway plinth, where there are currently no steps at all.
- Undertake further scrub removal in areas adjacent to the mill, the Trease Shaft spoil dump, and at the sites of now-demolished structures documented on the St. Just Tithe Map and the first and second editions of the OS 25" to a mile mapping.
- Undertake further research to determine whether historic photographs of the buildings at North Boscaswell mine are held in local collections or by individuals, as these will greatly assist the interpretation of the site if they can be located.

Low priority

- Reset loose coping stonework on the wall defining the edge of the walkway to the west of the dust chambers.
- Hand clear the fills from the small tanks adjacent to the western side of the lower floor of the mill.
- Undertake any necessary repairs to the water tank adjoining the mill boiler house.
- Undertake patch repairs to the tin floor concrete floor slab where it abuts the kieving floor.
- Patch repair sumps, buddles, settling tanks, sections of floor slabs and other features where their cement facings are found to have been lost or have deteriorated.
- Hand excavate the interior of the probable powder house.
- Hand excavate the fills of the drainage channels to the north of the mill and undertake any necessary repairs to the stonework revetting them, where found to be present.

Annual/cyclical

- Monitor the line of the lode outcrop traversing the site for indications of subsidence.
- Monitor the condition of the fence around the outcrop workings.
- Monitor the security of the fixings holding down the grille over Trease Shaft.
- Apply glyphosate to any brambles found to be growing in crevices in the walls and floors of the mill, tin floors, powder house, buddles and tanks on an annual basis.
- Keep the mine service buildings, engine house and associated boiler house clear of encroaching scrub through regular cutting.
- Control scrub development across the mine site as a whole through regular cutting and, if required, through further applications of Asulox to areas of bracken growth.
- Test the lightning conductor system on a regular basis.

9 Appendix: Recorded locations of Merton and similar furnaces

Although simple roasting furnaces (‘burning houses’) had been in use in Cornwall to clean arsenic and sulphides from tin ore for many centuries, and whilst more reverberatory furnaces were in use by the early 19th century, the vastly increased output of Cornish tin mines as the century developed required more efficient and sophisticated equipment to produce a clean tin product for the smelters. As a result a variety of mechanised calcining furnaces were developed between the mid-19th and the early 20th centuries, primarily for use in the ore treatment and chemical industries (in the latter these were predominantly used for the roasting of pyritic ores to produce sulphuric acid).

The first of these was designed by William Brunton. Initially introduced to Cornwall at Wheal Vor in 1835, this type of calcining furnace was soon to become popular and was adopted on a widespread basis across Cornwall and West Devon. Brunton calciners were also utilised during the retreatment of mine dumps during the early 20th century and continued in use until 1955 at South Crofty for the production of arsenic as a saleable by-product. The majority of Cornish mines employed Brunton pattern calciners (almost all of whose cast ironwork was produced at Cornish foundries) to clean arsenic from their tin, this type of calciner being simple to install and operate. Other types such as those subsequently developed by Oxland and Hocking, Humboldt and others were theoretically more efficient, though proved less robust, and were only adopted by a small number of Cornish mines.

Merton Furnaces began to be used at a limited number of sites in Britain and worldwide at the beginning of the 20th century, having been patented in 1903. They were primarily used in the processing of sulphide minerals for acid production and the treatment of zinc ores, though they are also recorded as having been used to treat ores of gold, copper and tin (in the last case to remove arsenic and sulphur from ore concentrates). The principal locations in which these, or their variants, were erected were in Swansea, South Wales and in Australia, though small numbers are also recorded from Canada, California and South Africa. Only three sites in Cornwall are recorded as having installed Merton Furnaces – North Boscaswell, Tresavean and Gwithian Streamworks. Given the overlapping working dates for these three undertakings they appear to have been three distinct sets of machinery and were not moved from one site to another.

The reason why the operators of North Boscaswell mine opted for the installation of a Merton calciner is uncertain, though its manager, Douglas Steuart does seem to have been interested in trying out new technologies (including the Pinder concentrators, patented in or around 1904) when equipping his dressing floors. It is uncertain, however, whether the North Boscaswell Merton Furnace was new when installed, as its iron components might have been bought second hand from a site elsewhere in Britain.

During the 20th century calcination was largely replaced in ore dressing by froth flotation, the first commercially successful (oil-based) plant being developed by Frank Elmore in 1897. Improved methodologies were developed around 1900, the first plant in Cornwall being that installed at United Hills, Porthtowan around 1906. In Cornwall, froth flotation became widely adopted after 1928, as an improved variant of Elmore's technology allowed for the recovery of a wide range of gangue minerals as well as a clean tin concentrate.

The following sites of Merton Calciner installations were identified through internet searches (first 20 pages of returned results):

- North Boscaswell, tin and copper, 1909, substantial remains.
- Tresavean, Lanner, copper and tin, 1905-28, limited remains including part of an associated flue.
- Gwithian Streamworks, 1912-39, tin (redeposited tailings material and re-worked spoil dumps), surviving chimney.
- Swansea, South Wales, many examples of calcining furnaces of various types (possibly including Mertons though mostly Brunton pattern) recorded as being used for roasting zinc blende and some other ores, sites redeveloped and no known remains.
- Avonmouth, a Merton Furnace was used in part of the acid production plant at the National Smelting Company's zinc works during WW1, no surviving structures.
- Sundown Mine, Queensland, Australia, copper and tin, 1915-25, partial foundation remains, Listed.
- Rocky Bluffs, North Queensland, tin, 1903-25, partial foundation remains.
- Mount Hepburn, Victoria, Australia, gold, 1896-1907, partial foundation remains.
- Glozier's Mill, Waratah, Mount Bischoff, Tasmania, tin, 1921 (25 rabbles), 1925 (27 rabbles), two large surviving examples of the Edwards type, later variants on the Merton Furnace. Steel framed with brick linings, drive machinery intact.
- Kalgoorlie, Australia, gold, no remains.
- Rossland and Trail Creek, Canada, late C19, O'Hara type, copper with some gold and silver, no remains thought to survive.
- Leeuwpoort Mines, Transvaal, South Africa, tin, no remains survive.
- Royal Consolidated Gold Mine and Mills, California, 1904, no remains survive.
- Hall Mining and Smelting Co, Canada, 1905, silver-lead and copper, no known remains.

It appears, therefore, that the example at North Boscaswell is extremely rare, and certainly of international significance.

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11 Project archive

The CAU project number is **146464**

The project's documentary, digital, photographic and drawn archive has been lodged with the National Trust.

A copy of the electronic project data is stored in the following locations:

Project admin: \\Sites\Sites T\Trease consolidation Phase 2\Background\

Communications: \\Sites\Sites T\Trease consolidation Phase 2\Communications\

Digital photographs: \\Historic Environment (Images)\Sites Q-T\Trease consolidation Phase 2\

Electronic drawings: \\Historic Environment (CAD)\CAD Archive\Sites T\Trease consolidation Phase 2\

Report: \\Historic Environment\Projects\Sites\Sites T\Trease consolidation Phase 2\Report\

Historic England/ADS OASIS online reference: cornwall2-251887

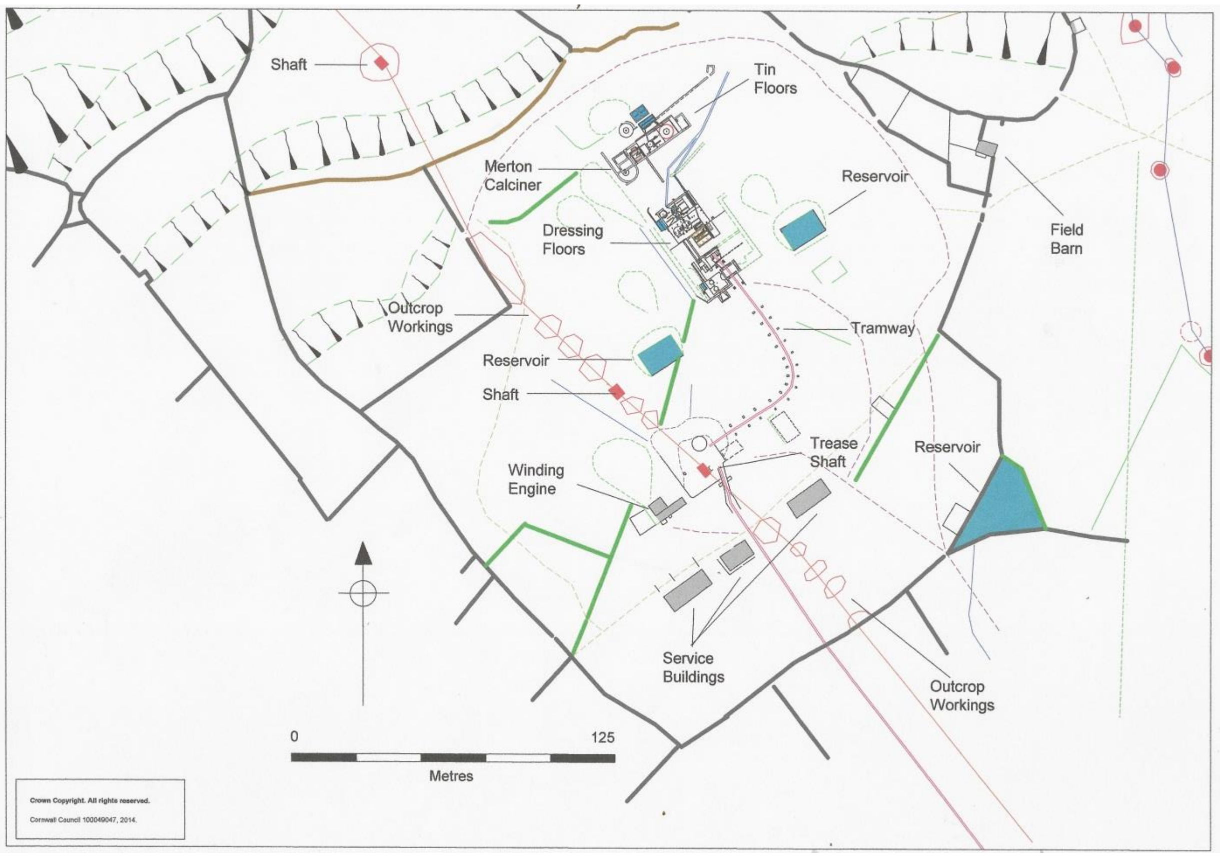

Fig 3. The principal site components at North Boscaswell referred to in this report.

Fig 4. A 1973 Potato Marketing Board aerial photograph of North Boscaswell Mine. North is towards the top right corner. The shallow workings on the outcrop of the lode passing through Trease Shaft are clearly visible on this image (left of centre and running north from the shaft).

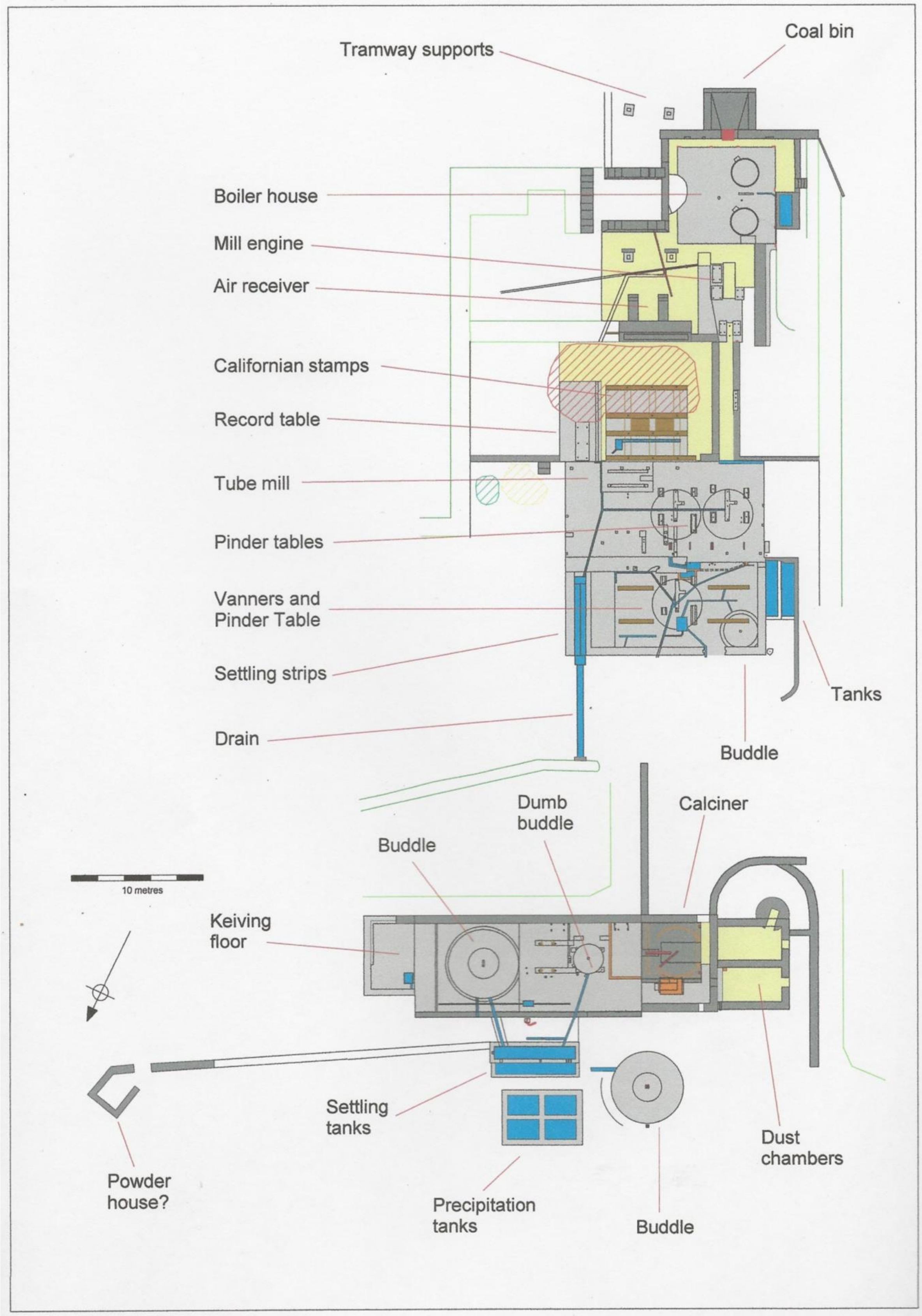

Fig 5. The 2015 CAU survey of the North Boscaswell mill and dressing floors showing the arrangement of its principal components.

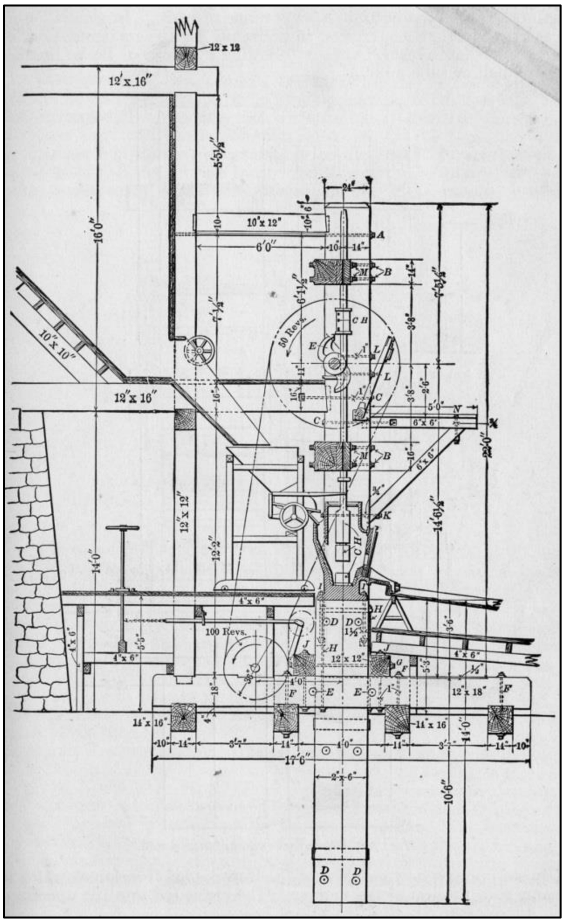

Fig 6. A section through a set of Californian Stamps contemporary with those installed on the North Boscaswell dressing floors. This provides useful detail for the mud cills – the horizontally-set timbers which supported the structure at ground level - and the timber anvil supports set deep into the ground to cushion the impacts of the falling stamps when they were in operation.

Fig 7. The crumbling remains of the timber mud cills and anvil supports (centre) on the North Boscaswell dressing floors, as well as the bolts which clamped the lower sections of the stamps timberwork together.

Figs 8 and 9. The eastern and western sides of the calciner furnace, showing the iron surround to the fire door (left) and the remains of the steel joists which had clamped the brickwork together to resist heat expansion forces (right).

Fig 10. The calciner from the west following rubble clearance in 2015. The whole of its original brick superstructure of the calciner had been removed following the closure of the mine and the scrapping of its components.

Fig 11. The calciner building (left) and dust chambers (right) showing the losses of original fabric from the western wall of the calciner and the eastern end of the northern dust chamber roof.

Fig 12. The Pinder Table floor in the mill. The poor condition of the concrete from which some of the plinths had been constructed is clearly evident.

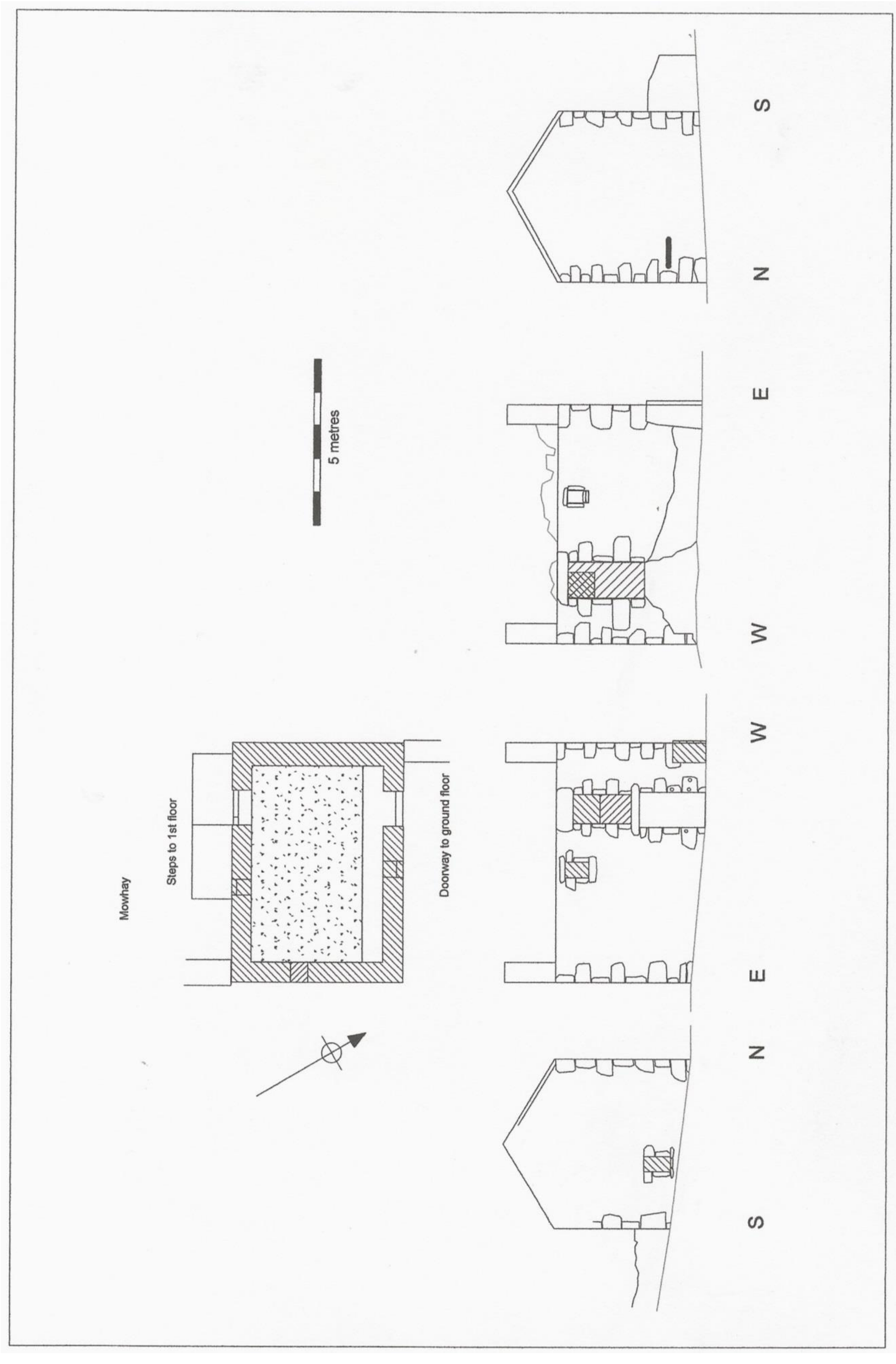

Fig 13. The CAU survey of the Trease field barn following ivy stripping.

Fig 14. Trease field barn from the south-west, showing the remains of the ramp/steps to the first floor door and the ivy which covered the southern elevation of the building.

Fig 15. Trease field barn from the north-east, showing the blocked windows and door in these elevations.

Fig 16. Trease Shaft prior to the clearance of the gorse which had encroached on it. The shaft is open to water at a depth of about 10m under the timber sleepers.

Fig 17. The Trease Shaft sleeper cover following the clearance of scrub vegetation. Paired tramway rails reused as shaft guides protrude through the cover. The sleepers were to be replaced by a galvanised steel grille (see Fig 86).

Fig 18. One of the linear drains (centre) running away downslope to the north of the Trease Shaft waste dump.

Fig 19. The eastern reservoir following scrub clearance by the NT.

Fig 20. The concrete pads for the tramway from Trease Shaft to the mill exposed during site clearance.

Fig 21. The foundations for the winding engine house and boiler house following clearance by the NT.

Fig 22. The fencing works to the shaft mound in the north-western fields.

Fig 23. The re-hedged and re-fenced adit shaft on the eastern boundary.

Fig 24. The re-fenced hedged shaft to the north of Trease Shaft.

Fig 25. Looking west along the track traversing the backfilled outcrop workings prior to works.

Fig 26. The geogrid reinforcement installed across the backfilled outcrop workings prior to the backfilling of this trench.

Fig 27. The 10m long trench to the west of the dust chambers excavated for the lightning conductor earth mats.

Fig 28. An early stage in the conservation works to the field barn.

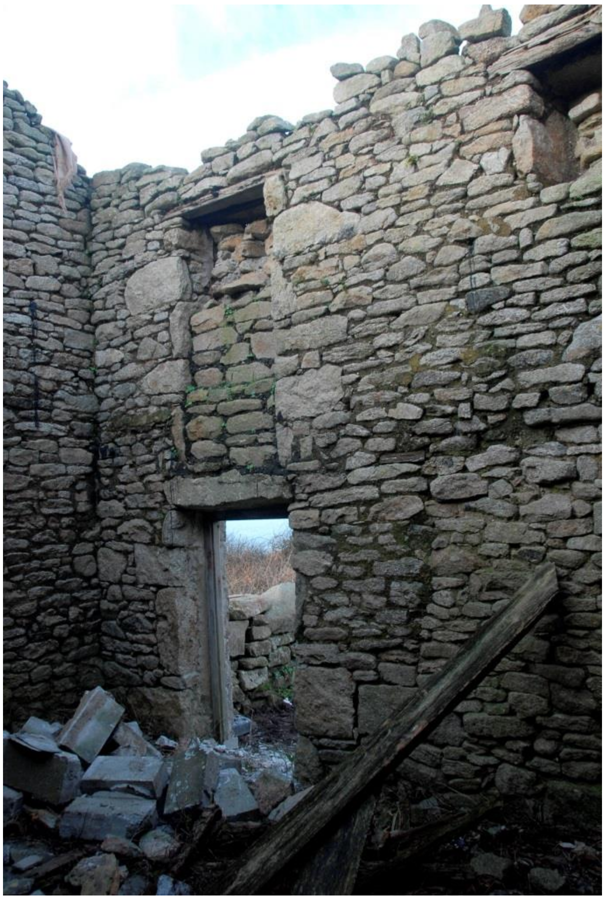

Fig 29. The interior of the field barn following the removal of the blocking to the ground floor doorway.

Fig 30. The poor condition of the ramp which formerly gave access to the upper floor of the field barn.

Fig 31. The repaired barn access ramp.

Fig 32. The completed northern face of the barn, showing the blocked upper floor doorway and windows and the lockable gate on the ground floor doorway.

Fig 33. A general view of work in progress on the mill.

Fig 34. Formwork in place around the most decayed of the Pinder Table mountings on the middle mill floor.

Fig 35. The re-formed Pinder Table mountings on the middle mill floor.

Fig 36. The badly undercut eastern edge of the middle mill floor prior to works.

Fig 37. The concrete underpinning works to the edge of the mill floor.

Fig 38. The significantly voided area at the rear of the lowest mill floor during its packing with loose stone and mortar to backfill it.

Fig 39. The completed repair works to the mill walling.

Fig 40. A view of the works undertaken to reconstruct the large plinth along the eastern side of the lower mill floor.

Fig 41. The small tanks external to the mill lower floor which would have collected run off from the nearby vanning tables.

Fig 42. The very poor state of the walling which supported the lower section of the Trease mill building prior to works.

Fig 43. The completed work to the walling around the lower mill floor.

Fig 44. Work in progress during the repair of the walling around the lower mill floor.

Fig 45. One of the replacement timbers set into the floor support sockets for one of the vanners, here crossing the buddle which it replaced.

Fig 46. Preparing the timber linings to support the grilles over the mill floor drains.

Fig 47. Installing grilles over drains on the tin floor.

Fig 48. The excavated stamps anvil sockets, showing the remnant timberwork in their bases.

Fig 49. Installing the reproduction stamps anvil support timbers.

Fig 50. The completed reproduction anvil support timbers and mud cills. The infill concrete next to the mud cills is deliberately darker than the original to distinguish the new work from the old.

Fig 51. The grille set between the mill engine loadings.

Fig 52. The buddle on the tin floors following the cutting out of its damaged brickwork. Salvaged bricks are being readied for the repair works.

Fig 53. Work in progress during the repair works to the buddle on the tin floors.

Fig 54. The rebuilt damaged section of the eastern wall of the southern dust chamber.

Fig 55. The reinstated masonry forming the eastern wall of the northern dust chamber, incorporating the reconstructed flue opening.

Fig 56. Repointing the lower section of the southern wall of the calciner enclosure in lime mortar. The upper section of the wall, which includes the location of the end of a feed hopper (top centre), was repointed in a cement mix to match the surrounding mortar.

Fig 57. Patch repairs to a major crack on the western wall of the dust chambers.

Fig 58. Making up the formwork on which the replacement section of the northern dust chamber roof would be cast.

Fig 59. Forming the new section of concrete roof over the northern dust chamber.

Fig 60. Grouting cracks in the roof of the dust chambers prior to the coating of the whole roof with Fosrok Brushbond to waterproof it.

Fig 61. Applying the Fosrok Brushbond to the dust chamber roofs.

Fig 62. Drilling the five metre horizontal hole near the head of the dust chamber northern wall which would take one of the Cintec reinforcing bars.

Fig 63. Drilling one of the vertical drill holes for the Cintec reinforcing bars to be installed within the northern wall of the dust chambers.

Fig 64. The only visible evidence for the Cintec reinforcing bars installed into the northern dust chamber wall (centre).

Fig 65. Joints crossing a vertical crack in the calciner enclosure northern wall cut out to receive helicoil bedjoint reinforcement.

Fig 66. A general view of the dust chambers during the later stages of conservation work to them.

Fig 67. The completed works to the lower section of North Boscaswell mill.

Fig 68. An overview of the tin floors at an early stage of the project showing (foreground) the calciner bed prior to reconstruction works.

Fig 69. The reconstructed brickwork around the base of the calciner bed and over the discharge vault and (background) the replacement steelwork support to the walkway which formerly accessed the calciner feed hopper.

Fig 70. The calciner bed prepared for its re-screeding.

Fig 71. Applying the Nitocote bonding primer to the calciner bed.

Fig 72. Laying the Paverok screed on the calciner bed.

Fig 73. The completed Paverok screed to the calciner bed.

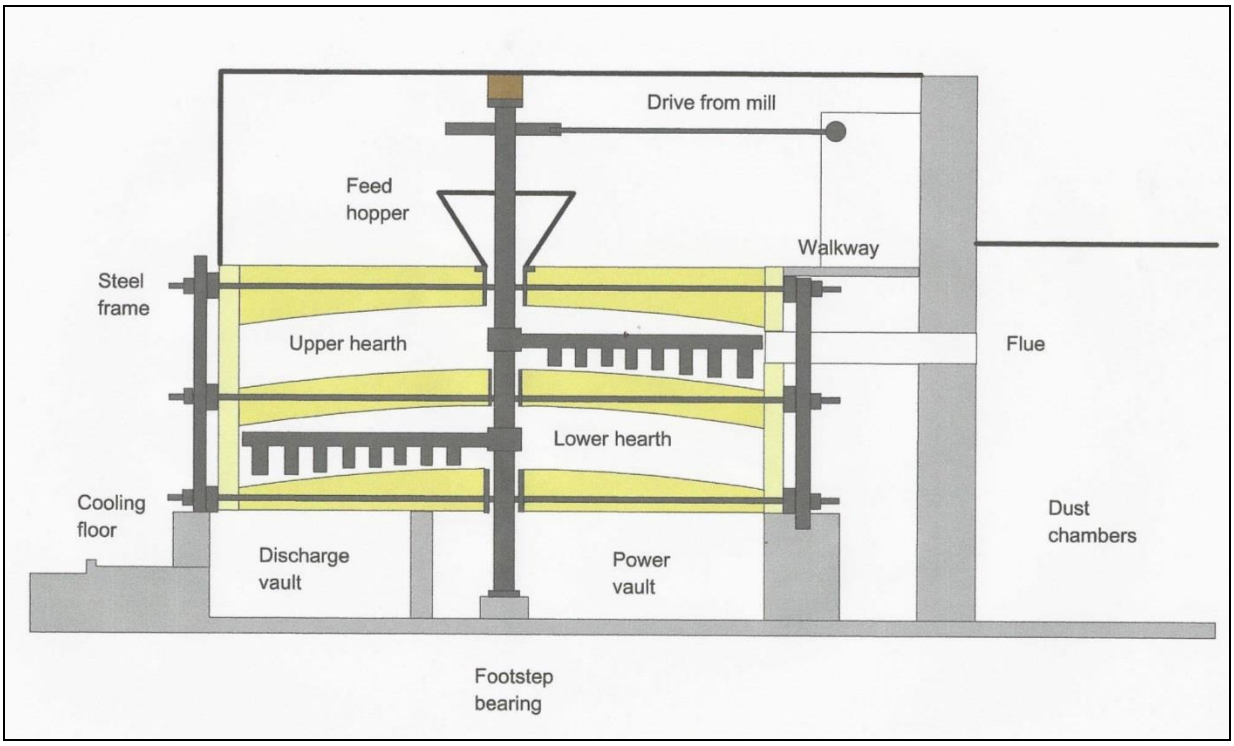

Fig 74. A schematic cross-section of the North Boscaswell Merton Furnace.

Fig 75. Hand excavation under way around the northern buddle.

Fig 76. The geotextile root barrier in place in the trench around the northern buddle. This was subsequently backfilled with an inert gravelly material.

Fig 77. The completion of the works to the precipitation tanks to the north of the tin floors.

Fig 78. Completed works to the revetment wall linking the tin floors to the probable powder house.

Fig 79. The probable powder house from the north east prior to works, showing the poor state of its masonry at this time.

Fig 80. The completed conservation works to the probable powder house.

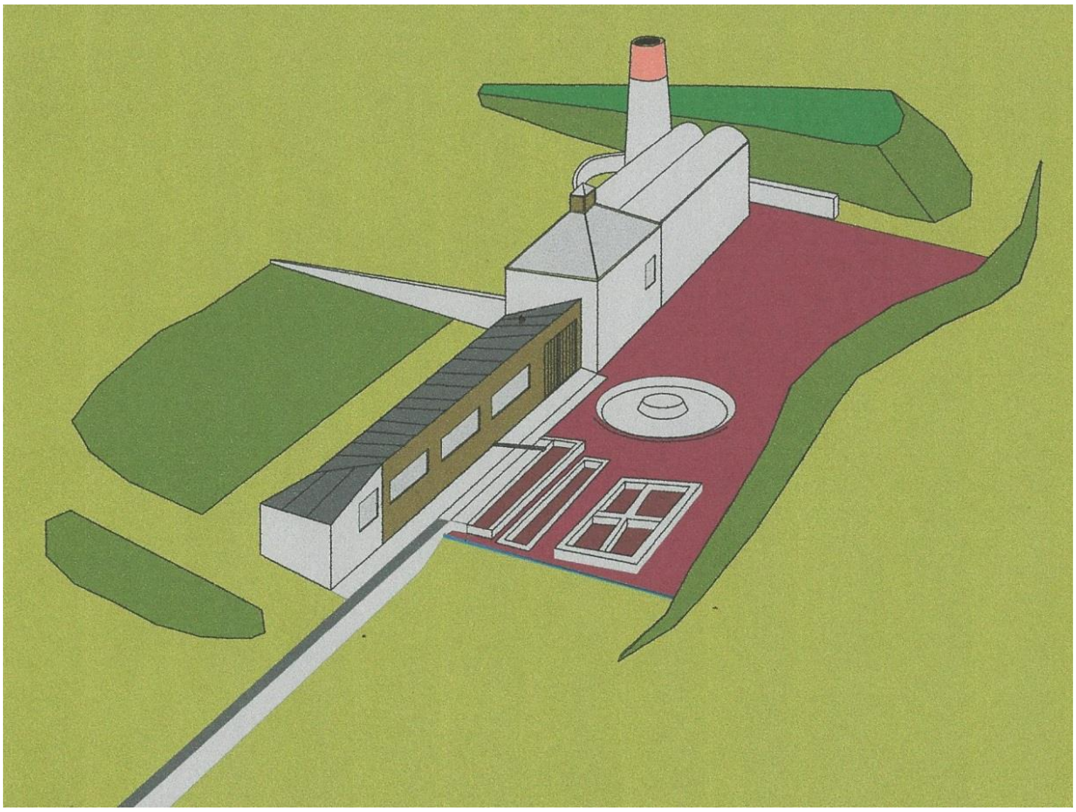

Fig 81. A simplified and hypothetical reconstruction of the original appearance of the tin floors at North Boscaswell.

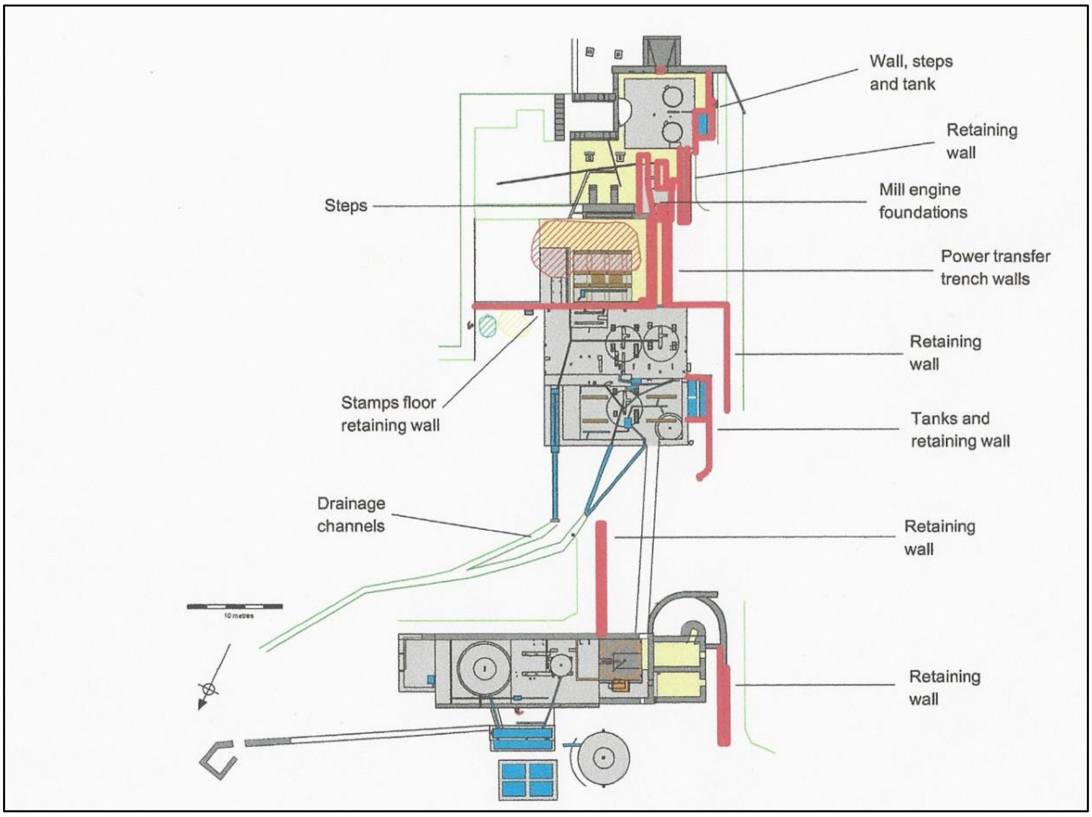

Fig 82. Outstanding conservation works at North Boscaswell dressing floors (highlighted in red).

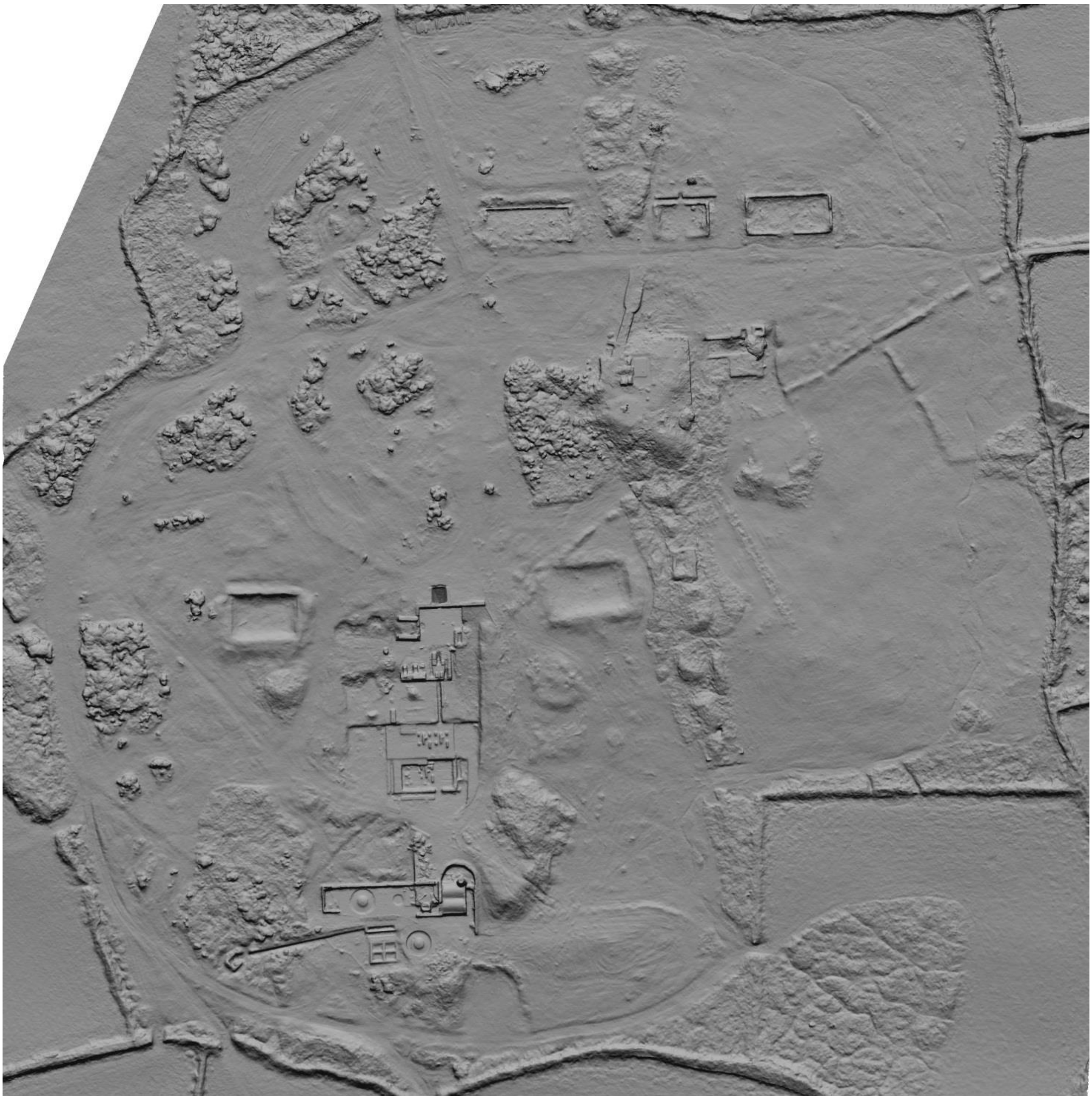

Fig 83. A rendered grey-scaled version of the drone-flown National Trust 2016 aerial survey of North Boscaswell Mine. This plotted a considerable amount of new detail, including the probable presence of an underlying early field system, as well as the mine buildings and associated earthworks such as roadways, tramways, drains and outcrop workings. Copyright © James Miles at Archaeovision.

Fig 84. Manoeuvring the first section of the new steel grille onto Trease Shaft once the sleeper cap had been partly removed.

Fig 85. The northern elevation of the upper section of Trease Shaft during the installation of the new grille, showing the displaced tramway rail skip guides and the upper section of shallow workings behind them.

Fig 86. The completed Trease Shaft grille in place.

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