Wessex Archaeology

WHITE ROCK AND HAFOD WORKS, SWANSEA

Archaeological Evaluation and Assessment of Results

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White Rock and Hafod Works
Swansea, South Wales

Archaeological Evaluation Report and Assessment of Results

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Summary

Wessex Archaeology was commissioned by Videotext Communications Ltd to undertake a programme of archaeological recording and post-excavation work on an evaluation by Channel 4's 'Time Team' at the site of the White Rock Works (NGR 266300 194660) and the Hafod Works (NGR 266250 195020), Swansea, south Wales.

The White Rock Works (scheduled monument GM489) and the Hafod Works both played an important part in the creation of Swansea as a world leader in copper production. Little, however, was previously known about the state of preservation of either site. The scheme of works looked to address this question as well as try to inform future work. This report documents the results of the archaeological survey and evaluation undertaken by Time Team, and presents an assessment of the results of these works.

The main focus of the programme (three out of five trenches) was to examine the monumental Great Workhouse at the White Rock Works, a structure that at its creation in 1736 was one of the largest industrial buildings in the country. The new Great Workhouse was part of the evolution of industry from small workshop scale production to a more mechanised factory process, utilising long buildings with several furnaces and machinery arranged in a line according to their stage in the manufacturing process. A further trench was positioned over the believed location of a Manilla house (Manilla bracelets/armlets of copper were produced as a commodity to exchange for slaves) at the White Rock Works, and a single trench was located at the Hafod Works.

The trenches excavated within the Great Workhouse revealed a calcining furnace located near to two melting furnaces, all of which yielded evidence of lead manufacture, a concern developed at the White Rock Works by the late 19th century. The Manilla house trench uncovered part of a building, though no furnace remains, and from the overlying deposits came several assay crucibles probably used for assaying lead ore. The only positively identified copper furnace was revealed in the trench located at the Hafod Works, but only a small part was exposed.

The evaluation at the White Rock Works and the Hafod Works has shown that archaeological remains associated with the manufacture of metals, albeit mainly lead, survive below the demolition layers, though the results were limited by the small size of trenches and the excavations being restricted almost entirely to the uppermost levels. However, later lead-working technologies were identified at the White Rock Works, whilst small parts of at least one copper furnace were found at the Hafod Works, probably built in the late 19th century and demolished in the 1920s when the Hafod Works went out of use.

Further analysis and detailed publication of the results of this project is not warranted by the nature and scale of the findings, but it is proposed to submit a summary of the work to *Archaeology in Wales.*

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Acknowledgements

This programme of post-excavation and assessment work was commissioned and funded by Videotext Communications Ltd, and Wessex Archaeology would like to thank the staff at Videotext, and in particular Jobim Sampson (Series Editor), Val Croft (Head of Production), Ellie Hunt (Researcher) and Laura Meacham (Production Co-ordinator) for their considerable help during the recording and post-excavation work.

The geophysical survey and field survey was undertaken by John Gater, Jimmy Adcock, Claire Stephens and Emma Wood of GSB Prospection. The landscape survey and map regression was undertaken by Alex Langlands. The excavation strategy was devised by Francis Pryor. The on-site recording was co-ordinated by Chris Harrison, and on-site finds processing was carried out by Justin Wiles, both of Wessex Archaeology.

The excavations were undertaken by Time Team's retained archaeologists, Phil Harding (Wessex Archaeology), Matt Williams, Ian Powlesland, Raksha Dave, Cassie Newland and Tracey Smith, assisted by Nick Wells, Alice Forward, Matt Nicholas and Caroline Pudney.

The archive was collated and all post-excavation assessment undertaken by Wessex Archaeology. This report was compiled by Chris Harrison and edited by Phil Andrews, with specialist reports prepared by Lorraine Mepham. The illustrations were drawn by Chris Breeden. The post-excavation project was managed on behalf of Wessex Archaeology by Lorraine Mepham.

Finally thanks are extended to Steven Hughes (RCAHMW), Neil Maylan (GGAT), John Berry (CADW) and Richard Porch (CCS) for their advice during and after excavations.

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Archaeological Evaluation Report and Assessment of Results

1 INTRODUCTION

1.1 Project Background

1.1.1 Wessex Archaeology was commissioned by Videotext Communications Ltd to undertake a programme of archaeological recording and post-excavation work on an evaluation by Channel 4's 'Time Team' at the site of the White Rock Works and the Hafod Works, Swansea, south Wales (hereafter the 'Site') (**Figure 1**).

1.1.2 The project was designed by Videotext Communications Ltd in consultation with the City and County of Swansea and the Royal Commission for Ancient and Historic Monuments, Wales (RCAHMW). Initial assessment of the Site as a potential subject for an archaeological narrative led to additional onsite discussion with Richard Porch, Regeneration Officer for the City and County of Swansea, and Stephen Hughes, RCAHMW.

1.1.3 The project examined two sites that were developed at different stages in the history of the copper works. The White Rock Works (Area 1) represents an early stage in the development of copper producing technology, whilst the Hafod Works (Area 2) represents a later stage. These sites were run by different companies with different sets of investors.

1.1.4 The White Rock Works and the Hafod Works both played an important part in the creation of Swansea as a world leader in copper production during the 18th and 19th centuries. However, little is known about the state of preservation of either site. The current scheme of works looked to address this question. This report documents the results of the archaeological survey and evaluation undertaken by Time Team, and presents an assessment of the results of these works.

1.2 The Site, Location and Geology

1.2.1 The Site was located over two distinct areas: the first (Area 1) at the former White Rock Works (centred at NGR 266300 195660); and the second (Area 2) at the former Hafod Works (centred at NGR 266250 195020). The Site as a whole lies at a height of approximately 10m aOD. The underlying geology consists of Upper Coal Measures and Pennant Sandstone (BGS Sheet 247). The Site is approximately 6 miles (9.5 km) north-east of Fairwood and approximately 3 miles (5 km) south-west of Coedffranc (**Figure 1**).

1.2.2 The areas of investigation are owned by the City and County of Swansea. The land is currently in use as a public park (Area 1) and for parking (Area 2).

2 ARCHAEOLOGICAL AND HISTORICAL BACKGROUND

2.1.1 The historical and archaeological background of the site was detailed in a project design issued by Videotext Communications Ltd (2011) prior to fieldwork commencing. The

historical and archaeological background of industrial Swansea, particularly its copper works, has been investigated and published by the RCAHMW (Hughes 2000). Information from these documents has been summarised below.

2.2 Prehistoric and Roman

2.2.1 Evidence for activity dating to the prehistoric and Roman periods in the general vicinity is limited to a few isolated findspots, including a coin hoard. However, the data seems to suggest that this activity was related to a ford crossing or bridge across the Tawe further to the north.

2.3 Medieval

2.3.1 It is believed that Swansea originated as a Scandinavian trading port in the 9th and 10th centuries. The first definite record of Swansea, however, appears in the 12th century in a charter by William Earl of Warwick declaring that the original motte and bailey castle was to become the administrative centre for the Norman Lordship of Gower. Throughout the 12th century a town grew and prospered around the castle, until by the end of the 14th century, after several attacks from the Welsh and epidemics of plague, the population and fortunes of Swansea declined significantly (Gerrard 2007).

2.4 Post-medieval

2.4.1 During the 17th century, the expansion of the coal trade resulted in a marked rise in interest in Swansea as a commercial centre. By the end of the 18th century, new canals, docks and other infrastructure enabled Swansea to become a focus for the raw materials needed for heavy industry, so much so that by the end of the 19th century Swansea dominated the copper industry on a global scale. Two works instrumental in this process were the White Rock Works and the Hafod Works. The history of both is discussed below.

The White Rock Works

2.4.2 White Rock Copper Works was established in 1736 by a partnership from Bristol at a time when copper smelting was switching from blast-furnace to reverberatory furnace technology. The Works was internationally renowned for its product and process. The furnace hall at White Rock, at 340ft long and 40ft wide (104 m x 12 m), was one of the first large industrial-scale buildings of the Industrial Revolution, known to contemporaries as ‘The Great Workhouse’.

2.4.3 The single row of 20 reverberatory furnaces in the smelting hall at White Rock reflected the founding stages of the ‘Welsh Copper Smelting Process’. This replaced the smaller scale ‘Bristol Process’ utilising smelting-houses that only held four furnaces, and involved fewer roastings and meltings of each charge of ore in a smaller range of specialised furnace designs.

2.4.4 The standing remains of the White Rock Works includes a cut-and-cover canal tunnel (NPRN 85093) of 1783-5, the remnants of the much-altered 'Great Workhouse' of 1736 on the western side, and a re-excavated 17th century river dock flanked on the north by a series of stone-built quays, with decks made of cast blocks of copper slag, built in the 19th century. The early White Rock quay has collapsed and has been removed.

2.4.5 A Manilla house is likely to have been present within the Works, though the location is not certain. Manillas are metal bracelets or armlets which were a traditional African exchange medium, usually made of copper, bronze or brass; they were later produced in large numbers in England as ‘slave trade money’.

2.4.6 In 1870-1, lead and silver smelting were introduced at the White Rock Works, and this resulted in the building of a brick condensing flue up the side of Kilvey Hill and an inclined railway to remove the waste. Part of the latter was supported by a stone arch that also housed two flues and a chimney, and this still survives.

2.4.7 By 1879, OS maps had started labelling the White Rock Works as a manufacturer of lead, silver and copper. By 1899, the Works was labelled as a gold, silver and lead works, suggesting that by this time White Rock no longer manufactured copper.

2.4.8 The Works closed in 1924 and the site was almost completely cleared in the 1960s. The White Rock Works is now an area of open land on the eastern bank of the lower River Tawe, designated as the White Rock Industrial Archaeology Park.

2.4.9 The site of the White Rock Works has not been investigated extensively archaeologically. An archaeological appraisal was carried out in 2002/3 by Cambria Archaeology (Larkin 2004). This report, part of a study commissioned by the City and County of Swansea Planning Department, was designed to cover the nature, condition, potential and future management of the buildings and features at the former Yorkshire Imperial Metals site (YIM) at Landore, Swansea, adjacent to the White Rock site.

2.4.10 The 2002/3 archaeological survey comprised two elements. The first was a desktop study of relevant archives for cartographic sources, printed sources and selected documentary records. The second element was a field survey of the upstanding buildings, walls, structures and other archaeological remains.

2.4.11 This survey was followed by an archaeological excavation undertaken on the adjacent Upper and Middle Bank Works by Oxford Archaeology (OA) in advance of development by Barratt Housing. This work was extensive, uncovering significant archaeological remains of numerous building types, and established chronological phasing across the sites (OA in prep.).

2.4.12 In 2005 Glamorgan Gwent Archaeological Trust (GGAT) carried out a watching brief during the construction of a fence along part of the White Rock site. Evidence of a cobbled surface was observed in five postholes and one posthole contained a brick surface. Postholes in the area of the Great Workhouse encountered some dense redeposited slag and brick fragments presumably from the 1960s demolition (Hart 2005).

The Hafod Works

2.4.13 The Hafod Copperworks was founded in 1809-10 by the Cornishman John Vivian and represented a new scale of refining and output at the world centre of copper production in Swansea, for the first time employing over a thousand people rather than the hundreds employed at previous smaller works. Here the 'Welsh Copper Smelting Process' was used in its fully developed form with up to 20 roastings and meltings of each charge of ore in a variety of specialised types of reverberatory furnace. The works was the largest in the world when constructed and would have remained so until the mid-19th century. The use of the copper blast furnace was pioneered in the later 19th century at the Hafod Works and its original carefully planned double row of 27 furnaces was increased in piecemeal fashion until Hafod was one of the few remaining works to continue smelting at Swansea, operating until 1921.

3 METHODOLOGY

3.1 Aims and Objectives

3.1.1 A project design for the work was compiled (Videotext Communications 2011), providing full details of the research aims and methods. A brief summary is provided here.

3.1.2 The overall aim of the project was to characterise the nature and date of the Site and place it within its historical, geographical and archaeological context. Three particular objectives were:

- How well do structures associated with the copper industry survive under the present ground surface in areas proposed for investigation?
- Does currently known cartographic evidence for the Site match sub-surface archaeological remains?
- What was the function of structures existing on the Site?

3.2 Fieldwork Methodology

Landscape Survey

3.2.1 A landscape survey and analysis of the cartographic evidence was undertaken by Alex Langlands, the findings of which are integrated here in the results and discussion.

Geophysical Survey

3.2.2 Prior to the excavation of evaluation trenches, a geophysical survey was carried out across the Site using a combination of magnetic survey and ground penetrating radar (GPR) survey. The survey grid was tied in to the Ordnance Survey grid using a Trimble real time differential GPS system.

Evaluation Trenches

3.2.3 Five trenches were excavated (see **Figures 1** and **2**) using a combination of machine and hand digging. All machine trenches were excavated under constant archaeological supervision and ceased at the identification of significant archaeological remains. When machine excavation had ceased all trenches were cleaned by hand and archaeological deposits investigated.

3.2.4 All archaeological deposits were recorded using Wessex Archaeology's *pro forma* record sheets with a unique numbering system for individual contexts. Trenches were located using a Trimble Real Time Differential GPS survey system. All archaeological features and deposits were planned at a scale of 1:20 with sections drawn at 1:10, or as appropriate. All principal strata and features were related to the Ordnance Survey datum.

3.2.5 A full photographic record of the investigations and individual features was maintained, utilising digital images. The photographic record illustrated both the detail and general context of the archaeology revealed and the Site as a whole.

3.2.6 The work was undertaken between 19–21 July 2011. At the completion of site work, all trenches were reinstated using the excavated soil.

4 RESULTS

4.1 Geophysical Survey

4.1.1 Extensive modern landscaping at the White Rock Works (Area 1) has hampered analysis of the geophysical data. Although discrete ferrous magnetic anomalies have been identified within the general noise, but none of these can be confidently associated with *in situ* features. The material used in the landscaping probably accounts for most of the GPR reflectors, thereby providing little useful information of potential features.

4.1.2 At the Hafod Works (Area 2) some discrete ferrous anomalies might represent intact machine bases or similar, but could equally reflect general debris. Again, the GPR survey has been rendered ineffective by the widespread demolition overburden.

Magnetic Survey

Area 1 (White Rock)

4.1.3 The results display severe magnetic disturbance throughout and it has been difficult to isolate potential discrete responses (see **Figure 2**).

4.1.4 The background noise is marginally reduced towards the southern end of the grid where a distinct linear anomaly [A] is apparent, suggesting a drain or wall.

4.1.5 To the north several more discrete responses are highlighted, of which the strongest is [B], suggesting a substantial iron object, though the curious curving shape is difficult to explain. The significance of any of these anomalies is, however, called into question by the fact that this area was substantially landscaped in the late 20th century and the results may simply reflect material deposited by this operation. For this reason, the Time Team evaluation strategy was based primarily on early mapping and plans.

Area 2 (Hafod Works)

4.1.6 In this sample the general background levels are higher and there is an increased incidence of extremely strong responses (in the order of 1000+ nT) (see **Figure 2**). While this might reflect the different scale of works at Hafod (bigger works = more machines = more debris), it could also arise in part from recent land use (landscaping to form the car park).

4.1.7 Several discrete anomalies have been identified that indicate substantial iron objects or features. It is difficult to interpret these anomalies which may include, for example, *in situ* machine footings or rail tracks – and the data give no clue as to their precise nature and, crucially, whether or not they represent intact features or unstratified debris. More of these anomalies are present in the southern half of the grid, where they appear to be arranged in a broadly rectangular pattern around an apparently 'blank' area. This could support an interpretation of some *in situ* remains, but equally, without the prior knowledge that furnaces had been built here, it is unlikely that the anomalies would have been interpreted as having any archaeological potential.

4.1.8 An evaluation trench (Trench 2) was placed over anomaly [C] and this revealed substantial brick rubble deposits overlying an intact floor and an *in situ* metal machine base.

Ground Penetrating Radar (GPR) Survey

4.1.9 The GPR results are disappointing but perhaps not surprising given that both sites have, for the most part, a significant overburden of stone rubble, concrete, brick and other debris. The majority of the responses recorded are simply a reflection of this.

4.1.10 At the White Rock site (Area 1) very little is interpretable as obvious features relating to the Works, based solely on the geophysical data. The radargrams show a mass of reflectors and 'ringing' but these are primarily small-scale features and there is little that could be coherently traced between traverses as examples of continuous structure. Even after excavation it has been difficult to correlate the recorded responses with the layout of features within the trench, aside from linear anomalies [1] (not illustrated) possibly being an indication of the western side of the Great Workhouse building. Certainly over the east of the survey area, where a deep overburden exists, nothing correlates at all.

4.1.11 The results from the Hafod Works site (Area 2) are equally problematic, with the responses being almost entirely derived from variation within the overburden. There seems to be scant correlation between GPR anomalies and excavated features, based upon a visual inspection of the latter. However, it is possible that, for example, the rectilinear anomalies [3] (not illustrated) are related to genuine features but, again, these could simply be a coincidental component of the mass of demolition back-fill.

4.2 Aerial Photographs

4.2.1 Aerial photographs of the White Rock Works taken during 1946–7 show a channel (formerly a canal) east of the Great Workhouse (**Figure 3**). Shadows of the west wall of the Great Workhouse indicate interruptions along its length, suggesting that the wall could have been arched and open. Similar shadows probably representing openings are also visible at the southern end of the east wall, and perhaps the south end opened into the channel/canal at the back of the Great Workhouse.

4.2.2 Also visible on the aerial photographs are two bays running east to west, formed by three walls, creating divisions within the northern end of the Great Workhouse, separating this end from the central area and southern end. It is assumed that these divisions reflect separate working areas or possibly material stores.

4.3 Evaluation Trenches

Introduction

4.3.1 No trench was located to investigate geophysical anomalies due to the poor results of the survey. Instead the trench locations were chosen by studying cartographic evidence, aerial photographs and standing structures.

4.3.2 Trenches 1, 3, 4 and 5 were located within the area once occupied by the White Rock Works, whilst Trench 2 was located within the former Hafod Works (see **Figures 1** and **2**). Trenches 1, 4 and 5 in particular focused on the Great Workhouse in an attempt to reveal the monumentality of the former structure and the processes it housed.

4.3.3 The eastern wall of the Great Workhouse survives as a standing structure, holding back an embankment. Some attempt was made to record and assess the walling, although this was in a very precarious state and only limited access was possible. Trench 3 was located over what was believed to be the site of a Manilla house, where Manilla armlets of copper were produced as a commodity to exchange for slaves. Trench 2 focused on locating and identifying evidence for copper manufacturing in the Hafod Works.

4.3.4 All trenches on the White Rock site contained topsoil above a layer of demolition debris which was composed of slag, clinker, ash, brick and waste materials from the manufacturing process. At the Hafod site, the ground surface was at the time of the evaluation a car park. Here, tarmac overlay a demolition layer full of slag, clinker, ash, copper waste and brick.

4.3.5 The depth to which archaeological deposits survive is not known, as in all trenches excavation was generally confined to the upper archaeological horizon and lower levels were not reached. All remains uncovered are, therefore, only understood (as far as possible) in plan, and in some cases the chronological relationships between deposits are not known.

4.3.6 Summary details of archaeological deposits are included in the trench summaries in **Appendix 1**.

*Trench 1 (**Figures 4–5**)*

4.3.7 Trench 1 was located over the northern end of the Great Workhouse in an attempt to locate evidence for copper production and to understand at which stage in the process of copper refining this end of the Great Workhouse operated. Trench 1 was excavated to the full width of the Workhouse (8.5m) and to the first archaeological horizon, at roughly 0.5m depth, although varying across the width of the Workhouse.

4.3.8 Topsoil and demolition layers were removed to reveal an old working surface, averaging 0.5m below the current ground surface. Due to a lack of stratigraphic evidence only three phases can be positively identified, the first of which (Phase 1) is categorised by evidence within the standing eastern wall that pre-dated the Phase 2 evidence below the Great Workhouse working floor (**1003** and **1015**), while Phase 3 was represented by the evidence associated with the working floor. The lack of stratigraphic evidence is due to the limited nature of the evaluation, rather than a lack of surviving material. From the evidence uncovered at the Site, and the nature of industrial sites elsewhere, it is highly likely that the evaluation revealed only a small sample of the sequence present.

Phase 1

4.3.9 Trench 1 included the western face of the eastern wall (**1030**) of the Great Workhouse, where it survived (**Figure 5**), parts of which also comprised the western wall of a channel running on the east side of the Great Workhouse. This channel was visible in places, and structures within the channel displayed evidence for the modification of the Great Workhouse. The channel almost certainly represents part of the covered canal, communicating with the open canal to the north and west. The eastern wall of the channel/canal was not uncovered, apart from its upper level, where it was constructed from regular, well hewn sandstone blocks. No attempt was made to clean or record wall **1030** in detail, for health and safety reasons.

4.3.10 The western wall of the Great Workhouse (**1002**) was revealed as a regularly coursed wall of well-hewn sandstone blocks that was interrupted along its length. This wall was similar in construction to the visible remains of the eastern wall of the channel/canal behind the Great Workhouse and also to the base of the eastern Great Workhouse wall (**1030**), suggesting contemporaneity.

Phase 2

4.3.11 The recorded elevation of the east wall of the Great Workhouse had three separate redbrick and firebrick arches, with a fourth tentatively identified (see **Figure 5**). It is possible that these arches mark the location of openings into the channel/canal behind the Great Workhouse. The arches were built to support an egg-shaped (in section) flue that would have run the length of the northern section of the Great Workhouse (see **Figure 5**). The flue was internally stained by sulphur, suggesting that it carried hot air exhaust, and it may have been used to trap and collect sulphur dioxide for use in making sulphuric acid, a by-product of the metal smelting industry. As the arches supported the flue, it is possible that an attempt was made to keep the canal operational at the same time as adding a flue

for the removal of exhaust gases from the Great Workhouse. The flue ascends slightly from north to south and continues both to the north and south of Trench 1.

4.3.12 Three slots were excavated in the Great Workhouse floor (see **Figure 4**). It was evident from these slots that the visible archaeology lay above the demolished remains of furnaces belonging to phase 2. An arched flue or drain (**1026**) was uncovered below phase 3 structures **1014** and **1023**, but as it was not excavated fully, its function and precise phasing remains unknown.

Phase 3

4.3.13 Running along the inside of the east and north walls of the Great Workhouse were several covered drains (**1011** and **1016**). In **1011** to the north was a lining of yellow firebricks (**1017**), whilst **1016** to the east was also brick-lined and in one place was overlain by several iron plates where it passed below a calcining furnace (see below). The Great Workshop floor at this time comprised a surface of red bricks, of which moderately extensive areas survived (**1003** and **1015**), laid on a levelling/bedding layer (**1022**).

4.3.14 The southernmost support arch within the channel behind the eastern wall of the Great Workhouse was slightly damaged on its southern edge by the insertion of a chimney or vertical flue (see **Figure 5**) that would have communicated with the north-south egg-shaped flue. This chimney/flue opened at its base into a large (7.7 x 5.3 x 0.2m) calcining furnace built of firebricks, stained yellow by sulphur. The western end of the calcining furnace had a smaller square firebrick structure at its southern end which would have acted as a firebox (**1013**). A piece of lead found within the fill of the furnace suggests that this structure was associated with lead production.

4.3.15 The southern edge of the calcining furnace was marked by one of the walls (**1028**) that divided the Great Workhouse and visible on the aerial photographs. The bay to the south was probably where ore for processing in the calcining furnace was stored.

4.3.16 To the north of the calcining furnace, and built on deposits **1031** and **1032** (brick, slag and clinker in varying amounts deriving from earlier furnaces), were two melting furnaces set side by side (**1014** and **1023**). The northernmost furnace (**1014**) was only half uncovered, but its construction was similar to the southern furnace (**1023**) in that a redbrick inspection/cleaning pit was constructed at the west end with steps descending into a firebrick-lined pit supporting iron firebars. This represents the only subterranean remains of the two furnaces, which would have resembled reverberatory furnaces. The above-ground remains to the east, possibly surviving as east-west redbrick wall **1007,** would have included the area supporting the melting basin. In this arrangement, an above-ground flue would have communicated with the egg-shaped flue in the east wall of the Great Workhouse.

4.3.17 Furnace **1023** at its east end had a pad of firebrick which may have continued further to the east, supporting the melting basin. This firebrick pad had droplets and accumulations of solidified molten lead within the gaps between the bricks. This further adds to the interpretation that the furnace was used for the production of lead not copper.

4.3.18 Furnace **1014** had a demolition cut (**1005**) above it, in which demolition rubble had been packed (**1006**). This shows that an attempt was made to remove the furnace, and the deposition of the rubble may indicate subsequent ground consolidation, suggesting that the Great Workhouse may have been re-used after the demolition of the lead furnaces. However, later demolition (**1001**) and landscaping of the ground during the 1960s–80s has resulted in the loss of information relating to this possible period of use.

Unphased

4.3.19 The north-west corner of the north wall of the Great Workhouse (**1027**) displayed the scar of a former entrance, blocked with redbrick and sandstone (see **Figure 5**), while to the east could be seen joist holes from two levels of former flooring or platforms. These holes may have functioned as the anchorage for a staircase to a platform that may have run the length of the east wall, providing an upper floor from which furnaces could be loaded. The phasing of this element in particular is ambiguous; it is assumed to belong to Phase 1 in its initial build, subsequently altered.

*Trench 2 (**Figure 6**)*

4.3.20 Trench 2 was located over the area of the Hafod Works in an attempt to assess the condition in which the copper furnaces survived. As a result of the demolition of the Works, the overburden below the car park surface was found to be 1.7m in depth (**2001/2**). The sides of the trench were therefore battered, resulting in the base dimensions of the trench being reduced to approximately 5.5 x 3m.

4.3.21 The trench was excavated to a maximum depth of 1.8m. The remains of two firebrick furnaces (**2006** and **2013**) were uncovered at the base of the trench, both of which had suffered severe heat damage and had been truncated by a later concrete pad (**2003/4**). Furnace **2013** survived as a pad of firebrick, aligned north-east – south-west, with copper residues fused to slag-attacked bricks. Above **2013** and within the general demolition material, a large square wrought iron frame (**2010**) for the base or side support of a furnace was uncovered. This may have functioned as the external tie for the furnace, helping to prevent fracture and damage during thermal movement.

4.3.22 Furnace **2006** survived in a more complete state than **2013**, although its continuation beyond the trench edge limited its interpretation. The furnace was constructed as a firebrick rectangle. At its north-west end was a possible rake out pit, filled with clinker and ash (**2009**). The structure was most likely a reverberatory furnace and one of several located within the Hafod Works as part of the refining of copper ore in the 'Welsh Process'.

4.3.23 Through the middle of the trench, poured concrete associated with two modern services was uncovered (**2003/4**).

*Trench 3 (**Figure 7**)*

4.3.24 Trench 3 was located over the supposed location of a Manilla house. The trench was excavated to a depth of 1.5m, at which point two sandstone walls were encountered: a 4.5m length of north-south wall (**3005**) wall abutted by a 4m east-west section of wall **3004**, the latter repaired with firebrick which had subsequently been heavily burnt.

4.3.25 The sandstone section of wall **3004** did not fully connect with wall **3005**; a gap of 1.2m between the two had been filled in with firebrick (**3008**). It is possible that this build blocked an entrance point to a subterranean room to the north of **3004.** This possible room housed a narrow channel (**3009**) running east-west along the north face of **3004**. To the north of this channel was a D-shaped, firebrick-lined structure (**3011**). This structure displayed slag attack along its internal face.

4.3.26 The structures were only uncovered in plan and their full surviving depths are unknown. Each structure had been infilled with building debris, suggesting that the phase of activity that they represented was the last before the building was demolished, or at least before its subterranean features were infilled.

4.3.27 Above the structures was a general dump of slag, clinker and firebrick (**3003**), within which were several assay crucibles. As Trench 3 lay close to the original dock location, it is possible that this was the site of a later assay house associated with the assaying of lead ore imported during the phase where the works concentrated on lead and silver processing, similar to Phase 3 in Trench 1.

Trench 4 (not illustrated)

4.3.28 Trench 4 was positioned to assess the survival of the western wall of the Great Workhouse towards its southern end. Excavation to a depth of 0.2m revealed a single section of sandstone walling that may have acted as a pillar base, consistent with the construction of an arched, open-sided wall as seen in Trench 1 and on the aerial photographs. Redbrick flooring was uncovered across the rest of the trench.

Trench 5 (not illustrated)

4.3.29 Trench 5 was excavated to assess the survival and articulation of the southern part of the Great Workhouse to the rest of the Works. Excavation to a depth of 0.4m uncovered a section of a double-skinned redbrick wall running across the entire width of the excavated area (**5003**). To the south of this wall, believed to be the southern wall of the Great Workhouse, a 2m wide channel was encountered, filled with clinker, slag and brick (**5005**). Over the channel were two wooden planks, forming a bridge (**5007**), creating a pathway into a narrow gap in the southern wall. This aligned with a raised firebrick trackway (**5004**) that snaked from north to south within the redbrick floor inside the Great Workhouse.

5 FINDS

5.1.1 A very small quantity of artefacts was recovered from the Site, mainly deriving from Trench 1. These fall into two categories: those that are related to industrial activity, and domestic refuse. The finds are quantified by material type and by context in **Table 1**.

5.2 Industrial

5.2.1 This category includes a very small quantity of industrial slag, from two contexts in Trench 1 (cinder/fuel ash slag, and copper slag); a portion of folded lead sheet and some melted lead waste; and two fragments of copper alloy sheet and a length of narrow copper alloy strip (folded).

5.2.2 Ceramic finds in this category include two complete/near complete fireclay scorifiers or assay crucibles, and two rim fragments from at least one further vessel, recovered from demolition layer **3002**. The crucibles are small and of convex profile (diameter 62mm/2½ inches, height 28mm/1 inch), and are stamped on the underside of the base BATTERSEA WORKS ENGLAND, surrounding '2½' within a triangle. Similar vessels, described as 'Battersea scorifiers', are included in the 1899 illustrated catalogue of John Taylor & Company of San Francisco (internet source, page 78).

5.2.3 Also found was a rectangular box-like fragment, clearly part of a series of such 'compartments', in refractory clay, almost certainly representing some kind of casting equipment (demolition layer **2002**).

5.3 Domestic

5.3.1 Five complete glass bottles and jars were found in demolition layer **1021**. These include an inkwell, a bottle and a jar each with screw caps in place, and a small brown bottle with a cork inside. None of the bottles or jars carries any identifiable proprietary marks, although one screw cap has a logo including the words 'At Your Service', and another jar

is embossed 'Made in the United Kingdom'. All are likely to be of early 20th century date, though it is uncertain whether they relate directly to activity in the Works, or whether they were deposited at the time of demolition.

5.3.2 The three sherds of pottery include two of refined whiteware, one transfer-printed; these represent tablewares (a plate/saucer rim and a small bowl rim). The third is a Bristol-glazed stoneware, from a cylindrical jar or bottle, which could have contained either a beverage (e.g. carbonated drink) or a household product such as blacking or ink. These sherds cannot be dated more closely than mid 19th century or later, and all are incidental finds here.

6 DISCUSSION

6.1.1 The trenches in Areas 1 and 2 have shown that archaeological remains associated with the White Rock Works and the Hafod Works survive below demolition layers. Interpretation, however, was severely limited by the size of trenches and the excavation being almost entirely restricted to the uppermost levels at both sites. Nevertheless, later lead-working technologies were identified in Area 1, whilst the furnaces uncovered in Area 2 were probably late rebuilds, demolished in the 1920s when the Hafod Works went out of use.

6.1.2 As the industrial processes that were targeted at the beginning of the evaluation were not fully identified, it is difficult to relate any of the results to the research aims. It is also hard to state the significance of the findings beyond the fact that the archaeological deposits survive well. The industrial processes would have involved extensive and potentially complex sequences of machinery and furnaces that can be understood when seen together, but something not easily interpreted here. However, from the White Rock site we can see that the factory was multi-phased and continued as a working concern producing lead after it stopped manufacturing copper. Also, the limited 'windows' into the earlier archaeological deposits showed that the lead furnaces were probably built upon the remains of copper-manufacturing structures.

7 RECOMMENDATIONS

7.1.1 An OASIS online record (http://ads.ahds.ac.uk/projects/oasis/) will be initiated and key fields completed on Details, Location and Creators Forms. All appropriate parts of the OASIS online form will be completed for submission to the AHBR. This will include an uploaded .pdf version of the entire report (a paper copy will also be included with the archive).

7.1.2 Further analysis and detailed publication of the results of this project is not warranted by the nature and scale of the findings, but it is proposed to submit a summary of the work to *Archaeology in Wales.*

8 ARCHIVE

8.1 Museum

8.1.1 It is recommended that the project archive resulting from the excavation be deposited with the National Museum of Wales. Deposition of the finds with the Museum will only be carried out with the full agreement of the landowner.

8.2 Preparation of Archive

8.2.1 The complete site archive, which will include paper records, photographic records, graphics, artefacts and digital data, will be prepared following the standard conditions for the acceptance of excavated archaeological material by the National Museum of Wales, and in general following nationally recommended guidelines (Walker 1990; SMA 1995; Richards and Robinson 2000; Brown 2011).

8.2.2 All archive elements are marked with site code (77507), and a full index has been prepared. The archive comprises the following:

- 1 cardboard box of artefacts
- 1 file of paper records & A3/A4 graphics
- digital data (photographs, spreadsheets, word-processed files, pdf files)

8.3 Copyright

8.3.1 This report, and the archive generally, may contain material that is non-Wessex Archaeology copyright (e.g. Ordnance Survey, British Geological Survey, Crown Copyright), or the intellectual property of third parties, which we are able to provide for limited reproduction under the terms of our own copyright licences, but for which copyright itself is non-transferrable by Wessex Archaeology. Users remain bound by the conditions of the Copyright, Designs and Patents Act 1988 with regard to multiple copying and electronic dissemination of the report.

9 REFERENCES

9.1 Bibliographic References

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Richards, J. and Robinson, D., 2000, Digital Archives From Excavation and Fieldwork: a guide to good practice, Archaeology Data Service

SMA 1995, Towards an Accessible Archaeological Archive, Society of Museum Archaeologists

Walker, K., 1990, Guidelines for the Preparation of Excavation Archives for Long-Term Storage, UKIC Archaeology Section

9.2 Maps

Ordnance Survey Landranger 159. 1:50,000. Swansea and Gower
Ordnance Survey Explorer 165. 1:25,000. Swansea
British Geological Survey Sheet 247. 1:25, 000. Swansea

9.3 Internet Sources

John Taylor & Company, 1899 catalogue of Assayers' Materials (accessed March 2013)

http://halslamppost.com/Mining%20Catalogs%20and%20Brochures/John%20Taylor%20Mining%20Supply%20Catalog.pdf

APPENDIX 1: TRENCH SUMMARIES

Trench No. 1	Co-ordinates: 266338 194708 Ground Level 12m on top of wall, 9.5m ground (aOD)	Dimensions: 22.8 x 10.2m Max depth: 1.2m
Context	**Description**	**Depth (m bgl)**
1001	Dark, humic, friable sandy clay topsoil and overburden. Contained modern finds including bits of shopping trolleys etc. Some demolition material i.e. bricks and stone, but may represent gradual decline and build up rather than the demolition event.	0-0.6
1002	West (sandstone) wall of the Great Workhouse; survives as 15 even courses in the north (13m) and as intermittent pads towards the south of Trench 1. A later drain runs through an opening in the north part of the wall. 0.75m in thickness.	0.6
1003	Firebrick floor with redbrick repairs, inside the Great Workhouse.	0.6
1004	Redbrick floor outside the Great Workhouse.	0.6
1005	Rectangular cut from the removal of a furnace (1014) in the north of the Great Workhouse.	0.6-1
1006	Mixed demolition rubble with yellow clay packing within 1005 overlying furnace 1014.	0.6-1
1007	East-west frogged redbrick double-skin single-coursed wall, running east from furnaces 1014 and 1023.	0.6
1008	Grey silty-sand levelling layer below 1003.	0.7
1009	East-west brick wall south of 1007 – north wall of calcining furnace.	0.5-0.7
1010	Yellow sulphurous-stained clay silt within calcining furnace in the middle to south of Trench 1. Contained lead slag. Possible final working of furnace, as calciners have drains to draw off the water. Sulphur is a common by-product of calcining and is collected and used to make sulphuric acid amongst other things. Not excavated as very contaminated.	0.7
1011	Cut along north wall of the Great Workhouse that has a drain built within.	0.5-0.7
1012	Mixed rubble deposit within drainage channel along north wall.	0.5-0.7
1013	Square firebrick structure, demolished to a single course. Calcining furnace.	0.5-0.7
1014	Melting furnace within north area of Great Workhouse; rectangular, double-skinned firebrick structure measuring 1.5 x 1.3m. The bricks alternate from header to stretcher etc. for 6 courses.	0.7-1.2
1015	Firebrick floor with redbrick repairs, inside the Great Workhouse. Possible continuation of 1003.	0.6
1016	Same as 1011 and articulates with 1011. Part of drainage network along eastern Workhouse wall.	0.5-0.7
1017	Drain constructed of yellow firebrick in 1011/1016.	0.5-0.7
1018	Levelling layer beneath 1017, within cut 1016, as seen in section along north wall. Composed of mid grey silty sand.	0.7
1019	Demolition material from 1016/1011 within drainage channel.	0.5-0.7
1020	Buttress extending out of north wall, inserted into the wall to retain the embankment behind.	

1021	Demolition area over 1010, separated from 1001 etc for finds purposes.	0-0.4
1022	Same as 1008, levelling layer below flooring 1015.	0.6
1023	Redbrick and firebrick box with sandstone steps at the west end, associated with melting furnace.	0-1.5
1024	Redbrick sub-square pad between 1014 and 1023.	0.7+
1025	Made ground for 1014 and 1023, sat above 1026. The made ground consists of firebrick and redbrick fragments, including some with copper slag attached.	0.7-0.8
1026	Curved redbrick flue beneath structures 1014 and 1023. Unexcavated.	0.8-1.2
1027	Northern wall of Great Workhouse.	
1028	Dividing wall between calcining furnace 1010 and storage area 1015.	0-0.5
1029	L-shaped redbrick wall defining part of the storage area, along with 1028.	0-0.5
1030	East wall of Great Workhouse, incorporating a flue and west wall of channel/canal.	
1031	Made ground comprising of broken brick and copper slag Overlies 1032 and sits below 1014 and 1023.	0.5-0.8
1032	Made ground below 1031, comprising ganister and clinker. Overlies 1026.	0.8-0.9

Trench No. 2	Co-ordinates: 266217 195103 Ground Level 9.7m (aOD)	Dimensions: 5.6 x 3.2m Max depth: 1.4
Context	**Description**	**Depth (m bgl)**
2001	Overburden, with rough tarmac surface. Comprised of demolition material, concrete, plastic shopping bags etc.	0-1
2002	Demolition layer, comprised of brick, clinker, ash and slag.	1-1.36
2003	Poured concrete floor, abuts brick wall 2005.	1.36+
2004	Poured concrete surface, lower than 2003, also abuts 2005.	1.40+
2005	L- shaped redbrick wall forming part of furnace 2006. Double-skinned and at least 4 courses deep.	1.38+
2006	Degraded and heavily-fired firebricks forming the base of a furnace. Within 2005.	1.38+
2007	Redbrick wall heavily heat affected, possibly part of the rake-out pit for furnace 2006.	1.38+
2008	Fill of probable rake-out pit 2007 – black ash.	1.38+
2009	Black ash deposit south-west of 2006.	1.38+
2010	Wrought iron tie bars for a furnace, at the base of 2002.	1.3+
2011	Clinker-rich deposit surrounding 2013 and below 2010. Possibly part of demolition.	1.38+
2012	Mottled brown sandy silt deposit with frequent slag, ash and clinker. Possibly basal layer of demolition.	1.38+
2013	Fire-brick wall/surface forming an edge/face that is heavily heat-affected and stained by copper. Possibly a slag pit or furnace.	1.38+
2014	Clinker patch near to 2010. Possibly part of 2011.	1.38
2015	Mixed redbrick and firebrick wall running between 2003 and 2004, 2 courses visible and double-skinned. Created from reused brick.	1.38

Trench No. 3	Co-ordinates: 266272 194722 Ground Level 9.9m (aOD)	Dimensions: 5.3 x 3.9m Max depth: 1.6m
Context	**Description**	**Depth (m bgl)**
3001	Levelling dump containing brick, stone and concrete fragments, as well as slag, in a dark grey sandy silt.	0-1
3002	Demolition layer consisting of yellow brown sandy clay mixed with rubble; contains assay crucibles.	1-1.6
3003	Slag dump between walls 3004 and 3005.	1.6+
3004	Sandstone wall running east-west for 3.5m, constructed from large sandstone blocks (0.4 x 0.2 x 0.1m) with a rubble core and bonded with a beige lime mortar. Brickwork 3008 was built onto 3004 and connects 3004 to 3005. Not fully excavated.	1.6+
3005	Sandstone wall running north-south and generally similar in construction to 3004. The west face has been repaired with brick. The top course at the south end has been rebuilt in brick (3006).	1.6+
3006	Brick structure built on top of the southern end of 3005, not fully excavated. At least 1 course deep.	1.6+
3007	Small double-skinned redbrick wall to the east of and parallel to the 3006; recorded for 1m length. Not fully excavated.	1.6+
3008	Stretch of brickwork blocking the gap between 3004 and 3005, and containing rubble 3013 to the north.	1.6+
3009	Roughly constructed redbrick channel covered by rubble 3013, not excavated. The channel is blocked by 3008 and forms a flue or rake-out pit beneath which may be a small crucible furnace (3010).	1.6+
3010	D-shaped firebrick-lined shaft (0.4m diameter), heavily heat-affected and slag-attacked, forming a hole for a crucible furnace.	1.6+
3011	Rubble covering crucible furnace 3010, part of 3002.	1.6+
3012	Compact black clinker layer east of 3005, running into section. Possibly a working surface but not fully excavated.	1.6+
3013	Brick rubble infilling channel and crucible cellar (3009 and 3010).	1.6+
3014	Rubble infill of 3009.	1.6+

Trench No. 4	Co-ordinates 266323 194661 Ground Level 9.7m (aOD)	Dimensions: 8.3 x 3m Max depth: 0.4m
Context		**Depth (m bgl)**
4001	Levelling dump containing brick, stone and concrete fragments, as well as slag, in a dark grey sandy silt.	0-0.4
4002	Redbrick and cobbled flooring to the east of 4003.	0.4+
4003	Stone wall fragment forming a plinth on which an arched pillar sat; part of the west wall of the Great Workhouse.	0.4+

Trench No. 5	Co-ordinates: 266314 194620 Ground Level 9.5m (aOD)	Dimensions: 6.7 x 5.3m Max depth: 0.2m
Context	**Description**	**Depth (m bgl)**
5001	Levelling dump containing brick, stone and concrete fragments, as well as slag, in a dark grey sandy silt.	0-0.2
5002	Redbrick flooring south of channel 5003 and external to the Great Workhouse.	0.2+
5003	South wall of channel, comprising two parallel single-skin redbrick walls (5003 and 5006); filled with rubble 5005 with 5007 over the top.	0.2+
5004	Four brick wide, curvilinear cart track running from north to south; passes through wall 5006 and adjoins wooden plank bridge 5007.	0.2+
5005	Rubble fill of channel 5003.	0.2+
5006	Wall constructed of a single skin of redbrick – forms the south wall of the Great Workhouse; cut through by cart track 5004.	0.2+
5007	Two wooden planks over channel, creating a bridge for cart track 5004 out of the south end of the Great Workshop.	0.2+

APPENDIX 2: ANCIENT MONUMENT REPORT

CITY AND COUNTY OF SWANSEA

ANCIENT MONUMENT

White Rock Copper Works, Pentrechwyth

Class: Industrial Site

Date of Notification: 24.10.95

National Grid Reference: SS 6629094720

O.S. 1:10000 Sheet No: SS 69 SE

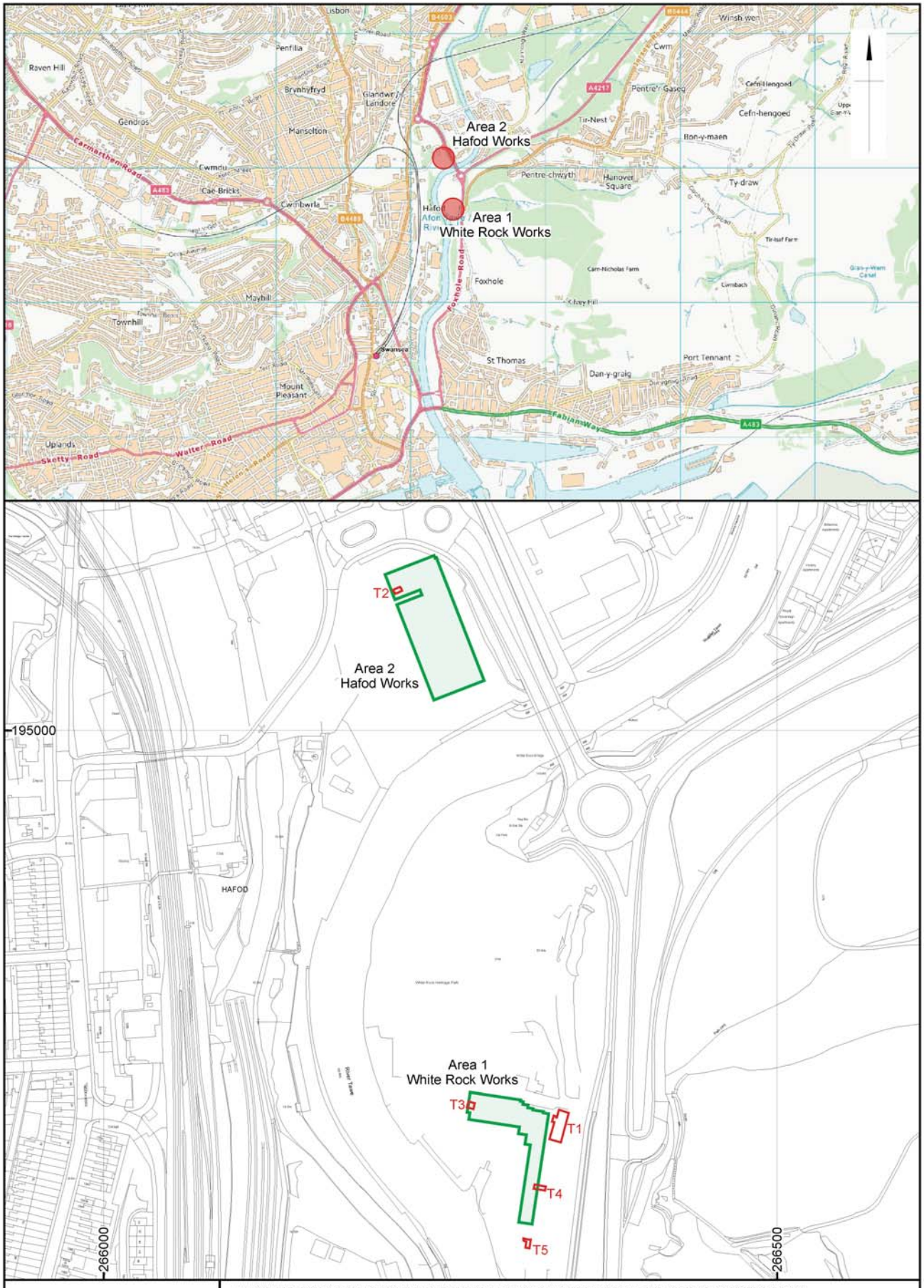
CADW Reference No: GM481

C & C of S Reference No: AM099

Notes:

White Rock was one of the most important copper smelting works in the Lower Swansea Valley, which was the world centre of non-ferrous smelting for much of the 18th and 19th Centuries. It was the third of Swansea's copper works to have been built, established in 1736. Although much of the site was cleared of upstanding buildings in the 1960s, a variety of important features survive above ground and the archaeological potential below ground is very high. The river wall to the west incorporates for shipping, some of which may date from the 1730s. The rear revetment wall of the 'Great Workhouse' survives and contains many apertures related to former kilns. A furnace survives near the north end of the site underneath the later slag incline to the eastern tips. The whole site is traversed by Smith's Canal of 1783, one of the earliest in Wales, which passes under the works in a cut and cover tunnel with underground wharves behind the 'Great Workhouse'. The flue on the hill to the east survives as a well marked stone-built trench.

The scheduled area incorporates the whole of the copper works site from the lower canal tunnel entrance in the south up to (but not including) the re-profiled slag heap in the north, and from the river quays on the west to a line 6m west of fencing of the road and cycle track on the east. The flue forms a detached area east of the main road. The site is known as the White Rock Industrial Archaeology Park and used for informal recreation. The flue is on uncultivated open ground.



Trench

Geophysical Survey

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Site location

Figure 1

Trench
Geophysical Survey
Magnetic geophysical anomaly
A Anomaly label

Geophysical survey data provided by GSB Prospection Ltd, Geophysical Survey Report 2011/43

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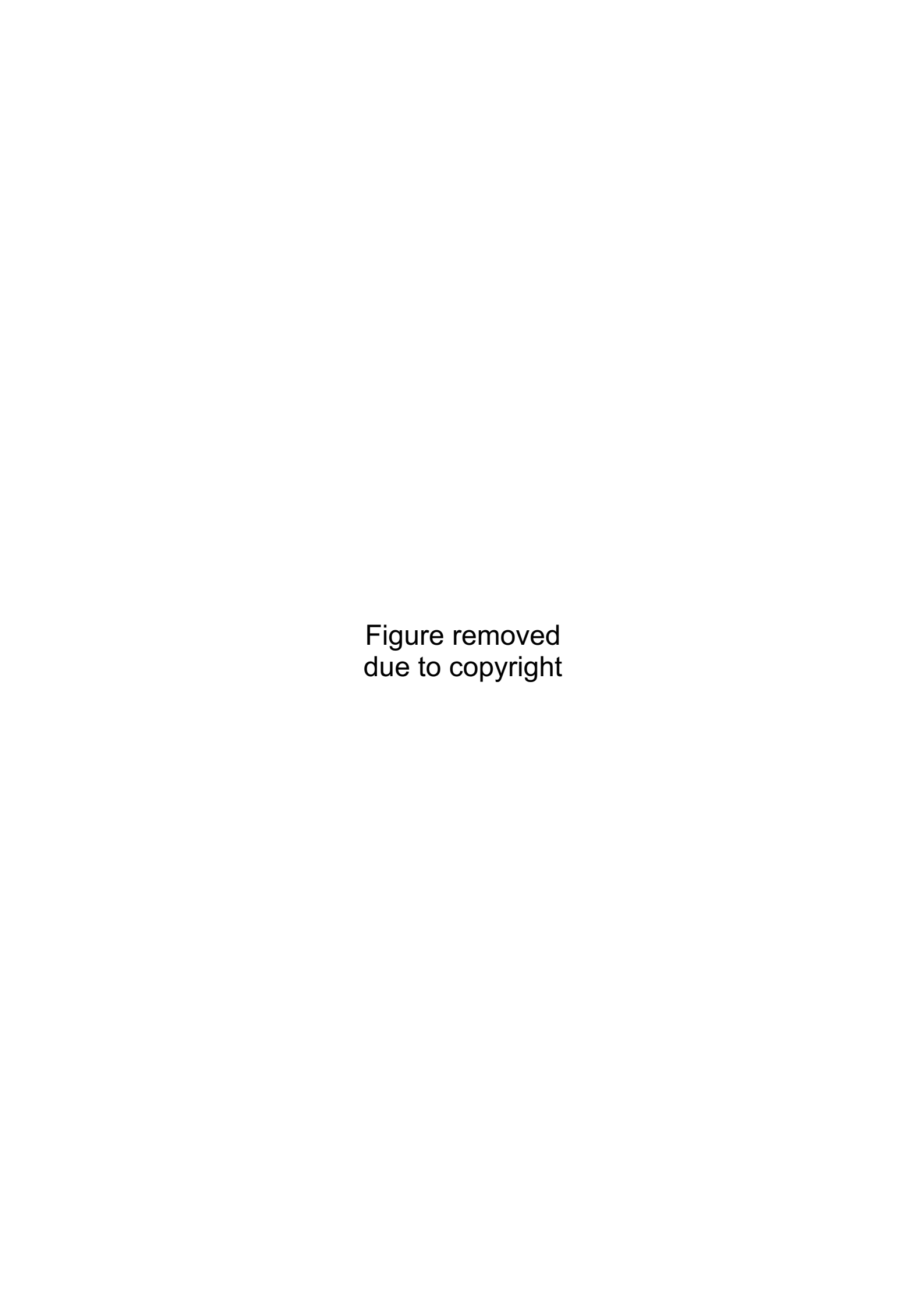
Trench location and geophysical survey results

Figure 2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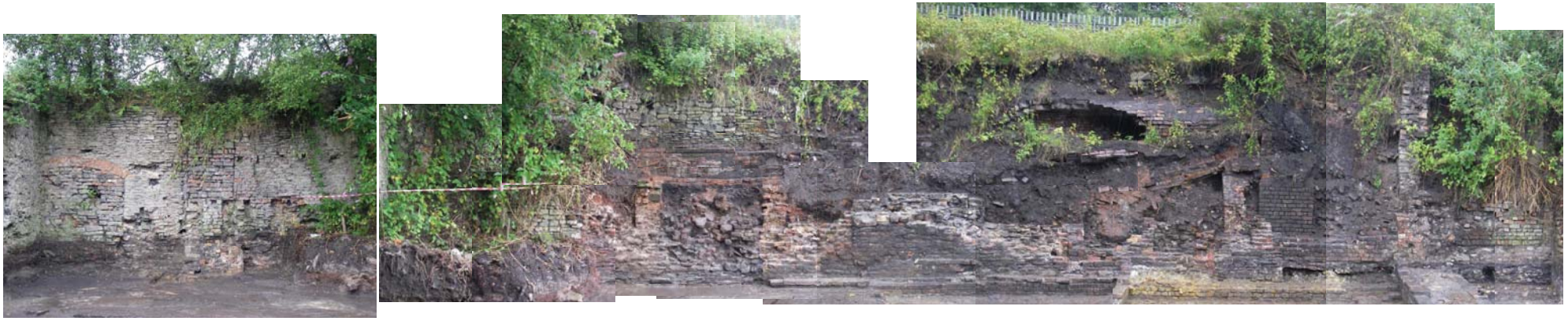
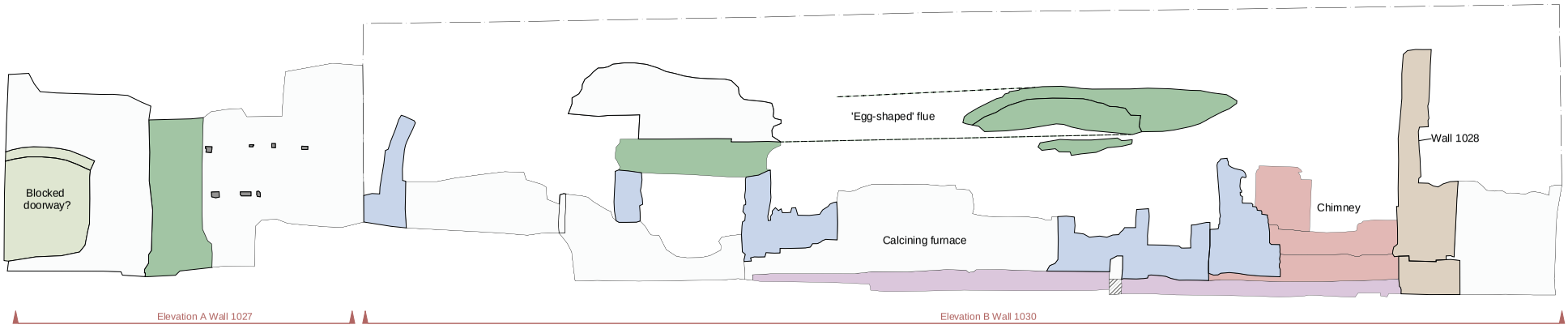
Trench 1: Plan (north end of Great Workhouse)

Figure 4





Flue | Support arch | Chimney | Furnace | Beam sockets

0 5m

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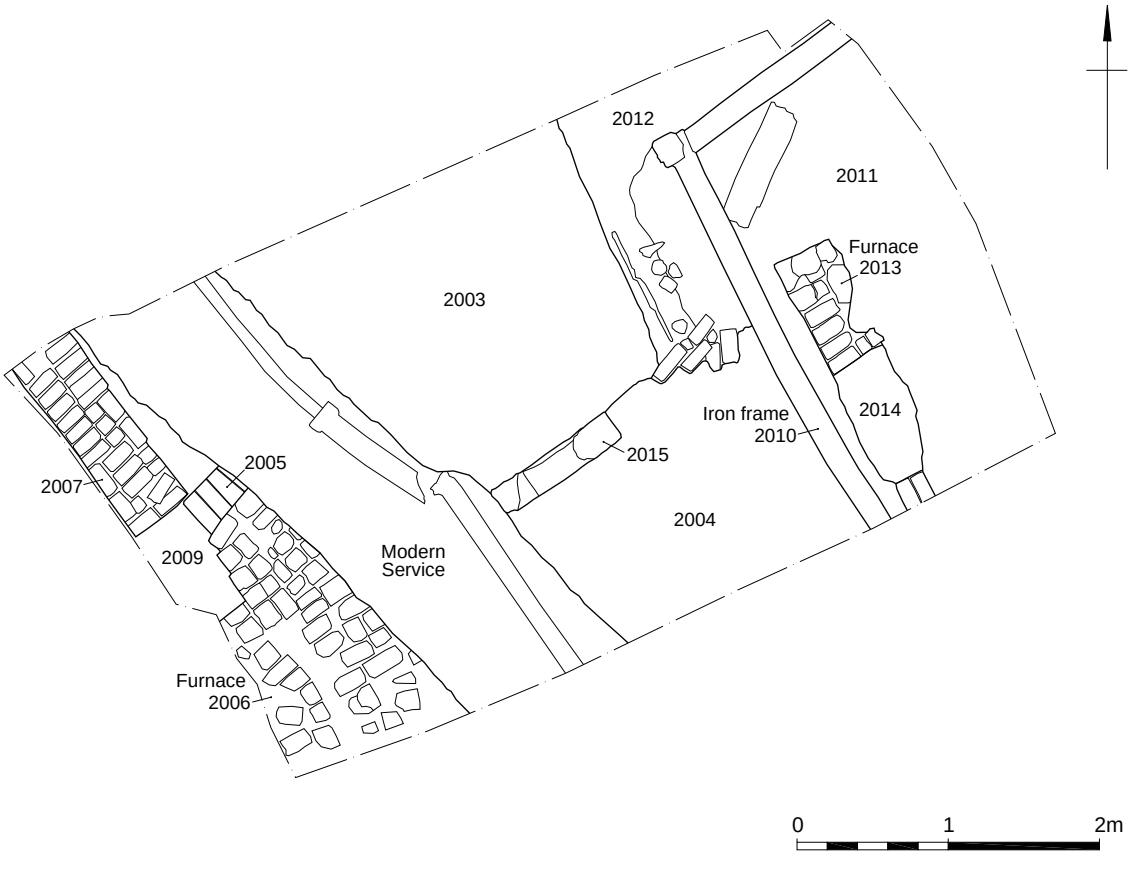
Elevations of Great Workhouse north and east walls in Trench 1

Figure 5

Trench 2, looking south-west



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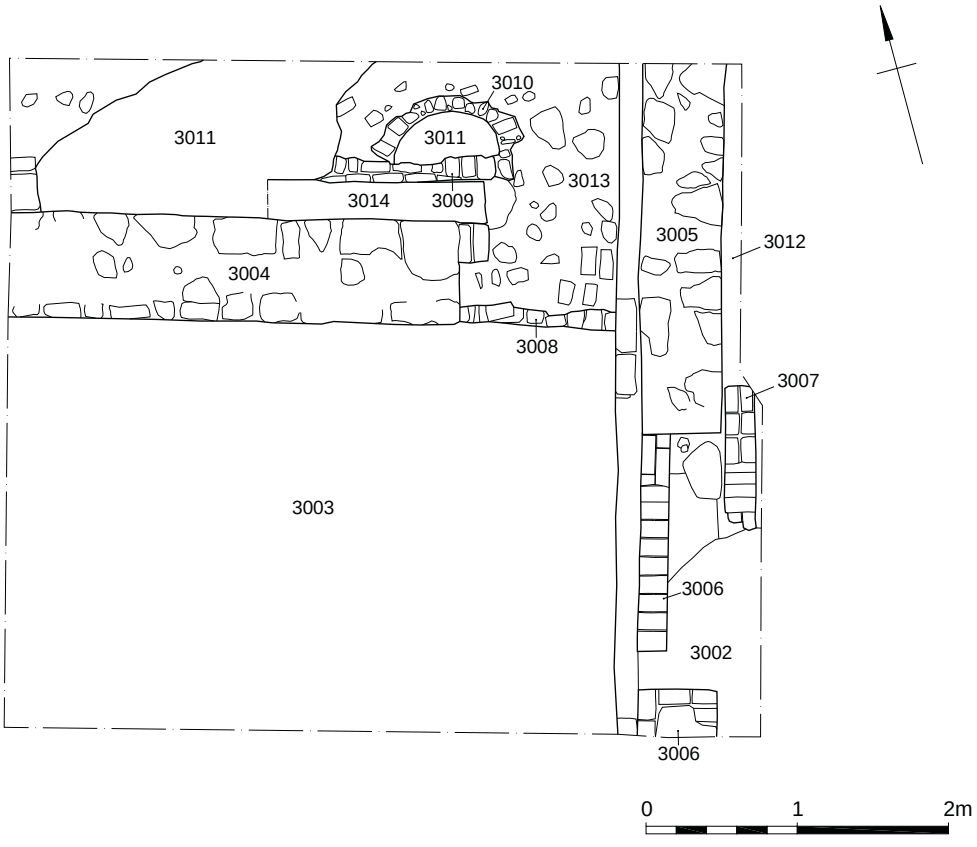
Plan of Trench 2

Figure 6

Trench 3, looking north-east



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Plan of Trench 3

Figure 7

Table 1: All finds by context (number / weight in grammes)

	INDUSTRIAL			DOMESTIC	
Context	**Slag**	**Metal (no.)**	**Other ceramic**	**Glass**	**Pottery**
1001					1/16
1010		1 Pb			
1012	1/160	3 Cu			1/4
1021				5/735	
1022		8 Pb			
1025	2/268				
2002			1/2000		
3002			4/221		1/9
TOTAL	**3/428**	**3 Cu; 9 Pb**	**5/2221**	**5/735**	**3/29**

Cu = copper alloy; Pb = lead

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