

# Vivian Engine House, Hafod-Morfa Copperworks

## Archaeological Watching Brief & Building Record



Prepared

For

**City and County of Swansea**

By



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## **Summary**

*Gofynnwyd Archeoleg Mynydd Du Cyf gan y ddinas a'r cyngor Abertawe i gwblhau briff gwyllo yn y Tŷ Injan Vivian (LB11695/NPRN33743), ar yr hen Weithdu Copr Hafod-Morfa, Abertawe, yn ystod gwaith lliniaru halogiad daear. Roedd y gwaith yn cynnwys y codi (cloddio), tynnu a gwaredu malurion a allai gynnwys asbestos o'r tu mewn a'r tu allan i'r strwythur.*

*Gofynnwyd Jonathan Green (Cadw) am y gwaith lliniaru halogiad arfaethedig i'w gwblhau o dan amodau briff gwyllo i ganiatáu'r recordio o'r nodweddion archeolegol/pensaernïol, strwythurau a/neu dyddodion aflonydd gan y weithdu.*

*Cloddwyd y malurion wedi'i leoli yn yr ardaloedd islawr a pwll peiriant o'r Tŷ Injan Vivian gan llaw gan Phoenix Asbestos Recovery Limited. Cafodd yr eitemau pensaernïol a diddordeb treftadaeth ei ffotograffio a gofnodi. Tra bod mwyafrif y malurion yn y ddwy ardal yn cynnwys rwbwl dymchwel heb ei haenu wedi'i gymysgu gyda sbwriel modern, daethpwyd o hyd i nifer o ddarganfyddiadau yn gysylltiedig â'r Weithdu Copr o'r dyddodion is yn y pwll peiriant.*

*Y darganfyddiadau mwyaf nodedig oedd bwrdd sbaner pren mawr a bowlen copr wedi'i morthwyllo, gyda cynulliad o offer gweithio copr a phwysau pres hefyd yn bresennol.*

*Roedd y broses o symud malurion yn cyflwyno cyfle unigryw i recordio'r nodweddion pensaernïol yn llawr islawr y Tŷ Injan Vivian.*

*Dadorchuddwyd yn bresenol sylfaen pwll olwyn wedi'i leinio â brics a siambr raff ynghlwm, swmp wedi'i leinio â brics a chwlfwr dŵr, sydd wedi hybu ein deallwriaeth o'r datblygiad a swyddogaeth yr adeilad. Cofnodwyd y nodweddion hyn ag ychwanegwyd nhw i'r cynlluniau arolwg a luniwyd yn flaenorol.*

*Mae'r adroddiad presennol yn nodi canlyniadau'r briff gwyllo archeolegol, a hynny'n unol â Safon Sefydliad Siartredig Archeolegwyr a chanllawiau ar gyfer briff gwyllo archeolegol. Cyhoeddwyd 2014.*

*The City and County of Swansea requested Black Mountains Archaeology Ltd/Archeoleg Mynydd Du Cyf to carry out an archaeological watching brief at the Vivian Engine House (LB11695/NPRN33743), on the former Hafod-Morfa Copperworks site, Swansea, during ground contamination mitigation works. The work involved the lifting (excavation), removal and disposal of debris potentially containing asbestos from the interior and exterior of the structure.*

*Jonathan Green (Cadw) requested the proposed contamination mitigation work be carried out under archaeological watching brief conditions to allow for the recording of archaeological/architectural features, structures and/or deposits disturbed by the works.*

*The debris located within the basement and the machine pit areas of the Vivian Engine House was excavated by hand by Phoenix Asbestos Recovery Limited. Items of architectural and heritage interest were photographed and recorded. Whilst the majority of the debris in both areas consisted of unstratified demolition rubble mixed with modern rubbish, a number of finds related to the Copperworks were recovered from the lower deposits within the machine pit.*

*A large timber spanner board and a hammered copper bowl are the most notable finds, with an assemblage of copper working tools and brass weights also present.*

*The exercise of debris removal presented a unique opportunity to record the architectural features within the basement floor of the Vivian Engine House.*

*In particular the brick-lined wheel pit base and attached rope chamber, a brick-lined basement sump and a water culvert have been uncovered, which have furthered our understanding of the building's development and function. These features were recorded and added to the previously drawn survey plans.*

*The present report sets out the results of the archaeological watching brief in accordance with Chartered Institute for Archaeologists Standard and guidance for an archaeological watching brief. Published 2014.*

### **Acknowledgements and Copyright**

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## 1. Introduction

### 1.1 Project Background and Proposals

- 1.1.1 The City and County of Swansea requested Black Mountains Archaeology Ltd/Archaeoleg Mynydd Du Cyf to carry out an archaeological watching brief at the Vivian Engine House (LB11695/NPRN33743), on the former Hafod-Morfa Copperworks site (Figure 1), Swansea, during ground contamination mitigation works. The work involved the lifting (excavation), removal and disposal of debris potentially containing asbestos from the interior and exterior of the structure.
- 1.1.2 Jonathan Green (Cadw) requested the proposed contamination mitigation work be carried out under archaeological watching brief conditions to allow for the recording of archaeological/architectural features, structures and/or deposits disturbed by the works.
- 1.1.3 The present report sets out the results for the archaeological watching brief in accordance with *Chartered Institute for Archaeologists Standard and guidance for an archaeological watching brief* Published 2014.

### 1.2 Objectives

- 1.2.1 The *definition* of an archaeological Watching Brief as set out by the *Chartered Institute for Archaeologists* (CIfA) is a formal programme of observation and investigation conducted during any operation carried out for non-archaeological reasons. This will be within a specified area or site on land, inter-tidal zone or underwater, where there is a possibility that archaeological deposits may be disturbed or destroyed. The programme will result in the preparation of a report and ordered archive.
- 1.2.2 The *purpose* of an archaeological watching brief (as defined CIfA 2014) is:
- to allow, within the resources available, the preservation by record of archaeological deposits, the presence and nature of which could not be established (or established with sufficient accuracy) in advance of development or other potentially disruptive works.
  - to provide an opportunity, if needed, for the watching archaeologist to signal to all interested parties, before the destruction of the material in question, that an archaeological find has been made for which the resources allocated to the watching brief itself are not sufficient to support treatment to a satisfactory and proper standard.
  - A watching brief is not intended to reduce the requirement for excavation or preservation of known or inferred deposits, and it is intended to guide, not replace, any requirement for contingent excavation or preservation of possible deposits.
  - The objective of a watching brief is to establish and make available information about the archaeological resource existing on a site.
- (*Chartered Institute for Archaeologists Standard and guidance for an archaeological watching brief. Published 2014*).

### 1.3 Legislative Framework

- 1.3.1 *Planning Policy Wales* (PPW 10th Edition) sets out the land use planning policies of the Welsh Government. Chapter 6 sets out the Welsh Government's policy towards the historic environment. It states "The historic environment of Wales is made up of individual historic features, archaeological sites, historic buildings and historic parks, gardens, townscapes and landscapes, collectively known as historic assets. The most important of these historic assets have statutory protection through scheduling, listing or designation as a conservation area. Other assets are included in formal registers, which identify them as being of special historic interest. Many others make a positive contribution to local character and sense of place. Some, such as buried archaeological remains, have still to be identified. It is important to protect what is significant about these assets and sustain their distinctiveness. Historic assets should be the subject of recording and investigation when they are affected by proposals that alter or destroy them. Historic assets are a non-renewable resource." (PPW 2018, 123-129).
- 1.3.2 Underpinning PPW are a series of legislative powers and TANs. The *Planning (Wales) Act 2015* sets out a series of legislative changes to deliver reform of the planning system in Wales, to ensure that it is fair, resilient and enables development. The 2015 Act also introduces a mandatory requirement to undertake pre-application consultation for certain types of development. The Town and Country Planning (Development Management Procedure) (Wales) (Amendment) Order 2016 defines in Schedule 4(l) the parameters and definitions for the requirement of pre-application consultation by Welsh Ministers, particularly in response to the effect of statutory designated monuments, buildings, and parks and gardens.
- 1.3.3 Advice on archaeology and buildings in the planning process was contained in *Welsh Office Circular 60/96 Planning and the Historic Environment: Archaeology and Welsh Office Circular 1/98 Planning and the Historic Environment*, which updated *Welsh Office Circular 61/96 Planning and the Historic Environment: Historic Buildings and Conservation Areas* following the Shimizu (U.K.) Ltd. v. Westminster City Council Judgement (February 1997). Detailed advice on Environmental Impact Assessment is contained within *Welsh Office Circular 11/99 Environmental Impact Assessment*. Following adoption of the TAN 24 Historic Environment on 31st May 2017, *Welsh Office Circulars 60/96 Planning and the Historic Environment: Archaeology; 61/96 Planning and the Historic Environment: Historic Buildings and Conservation Areas; and 1/98 Planning and the Historic Environment* have been cancelled.
- 1.3.4 Any works affecting an ancient monument and its setting are protected through implementation of the *Ancient Monument and Archaeological Areas Act 1979*. In Wales the 1979 Act has been strengthened by *The Historic Environment (Wales) Act 2016*. The 2016 Act makes important improvements for the protection and management of the Welsh historic environment. It also stands at the centre of an integrated package of secondary legislation (Annexes 1-6), new and updated planning policy and advice, and best-practice guidance on a wide range of topics (*TAN 24 Historic Environment*). Taken together, these support and promote the careful management of change in the historic environment in accordance with current conservation philosophy and practice.

- 1.3.5 The *Ancient Monument and Archaeological Areas Act 1979* and *The Historic Environment (Wales) Act 2016* sets out a presumption in favour of preservation *in situ* concerning sites and monuments of national importance (scheduled/listed), and there exists in the current *Planning Policy Wales (Chapter 6)* a presumption in favour of preservation *in situ* of all types of heritage assets.

#### 1.4 Location, Topography and Geology

- 1.4.1 The Vivian Engine House is centred on NGR 266175.245,194981.378, located within the former Hafod-Morfa Copperworks site, approximately 4km north of the city centre. The River Tawe flanks the southern extremity of the copperworks. Swansea is situated on Carboniferous Coal measures and the extraction of coal from this area has greatly influenced the history and development of the region. The soils over the study area are largely un-surveyed but are likely to include alluvium associated with the River Tawe and substantial peat deposits (SSEW 1983).
- 1.4.4 The geology generally comprises of the South Wales Upper Coal Measures formation, which is made up of Mudstone, Siltstone, Sandstone, Coal, Ironstone and Ferricrete and ranges between the geological ages of Westphalian D to the Bolsovian (West Phalian C). This sedimentary would have formed between 306 and 308 million years ago within the Carboniferous Period, and would have been dominated by rivers which deposited sand, gravel, detrital material, silt, clay and some bogs including alluvium. Superficial deposits within the development area are confined to clay, silt, sand and gravel, which would have been deposited in the Quaternary period approximately 2 million years ago (BGS Sheet 247).

#### 1.5 Archaeology and History

- 1.5.1 During the mid-19th Century the Hafod/Morfa Copperworks were the largest copperworks in the world employing over 1000 people. Situated in the Lower Swansea Valley, this area at that time accounted for 90% of the worlds copper production (Hughes 2000). This was made possible by a plentiful supply of coal in the Swansea Valley, brought down via the late 18th century canals, and the excellent facilities for shipping, which allowed the import of copper ore from Cornwall, North Wales, South America and Australia. The Hafod Copperworks was established in 1808-9 by the Cornish entrepreneur John Vivian. In 1835 a Cornish firm, Williams, Foster & Co., opened the Morfa works on adjacent land. The works was initially a rolling plant for making bars and plates from copper ingots brought from the nearby Rose Works but smelting is believed to have started at the same time. Both the Hafod and Morfa works amalgamated in 1924 and was subsequently operated by Yorkshire Imperial Metals until it closed in 1980, when it was the last operating copperworks in Swansea.
- 1.5.2 At least 15 or more significant structures, in varying degrees of condition, survive across the Hafod-Morfa Copperworks site. These include the rolling mill (LB 16878) now used as the museum stores, the laboratory building (LB 11690) and the former Morfa Powerhouse and later Yorkshire Imperial Metals canteen (LB 11691). The Hafod Limekiln (11694), Copper Slag Abutment, Pier and Canal Boundary Walls (LB 11692 and 11693). The Vivian Engine House (LB 11695), the Chimney (LB 11696) west of the Vivian Engine House and the Boundary wall for the Hafod Copperworks Canal Docks (LB16881). Finally, the *in situ* Musgrave Engine and Rolls (SAMGm483) in the Musgrave Engine House and Chimney (LB 11697).

- 1.5.3 The Vivian Engine House (LB11695/NPRN33743), is a rectangular free-standing two-storey building (and basement) with a chamfered NW corner. Built by at least 1860 potentially over the site of an existing but undocumented building. An ornate carved stone plaque with scrolls and flowers over the W door reads 'Commenced August 1860; completed February 1862; V & S'. The building is 14m by 9m aligned roughly E-W and built of pennant sandstone and ash bricks with a slate roof. The building housed a 24" vertical steam engine, which drove the roll-train in mill no.2.
- 1.5.4 The history of the Hafod-Morfa Copperworks is reasonably well understood, although many gaps in knowledge do exist pertaining to the function and layout of the buildings on-site. Useful resources include 'Copperopolis', Stephen Hughes' (2000) outstanding work on the copper industry in Swansea (and beyond) and for the Hafod-Morfa Copperworks, Dyfed Archaeological Trust's appraisal 'The Yorkshire Imperial Metals Site' (2002) is particularly helpful in understanding the archaeological potential of the remaining historic assets on the site. The description and survey drawings of the Vivian Engine House carried out by RCAHMS and featured in Appendix III of this appraisal, are reproduced again here in Appendix IV.



## 2. Methodology

- 2.1.1 The archaeological watching brief consisted of the removal (excavation) by hand of debris from the basement and machine pit areas of the Vivian Engine House. Whilst the primary purpose of this work was to mitigate against asbestos contamination preceding renovation works to the building, the exercise offered a unique opportunity to access and record the lower levels of the Vivian Engine House. It also enabled the recovery of items of architectural and heritage significance from these areas. The investigations were tied to the Ordnance Survey National Grid and Datum using an EMLID Reach RS GNSS/Glonass (GPS) Receiver and data logger with a 10-20mm tolerance.
- 2.1.2 The debris removal was carried out by Phoenix Asbestos Removal Limited under archaeological supervision. The debris material was excavated and shovelled into wheelbarrows, which were tipped onto an off-the-ground timber platform in order that it could be sifted for items of architectural or heritage significance before being disposed of as contaminated waste. Heavy items such as a large section of timber leat and a number of large concrete slabs were hoisted out of the wheel pit using a portable A-frame gantry hoist. As the work proceeded to the lower levels of the machine pit and basement sump the debris was shovelled into buckets and hoisted out of the building for inspection and disposal.
- 2.1.3 There were some challenges to the work, principally the continuous flooding of lower levels by rain and rising groundwater, which was tackled with the use of bilge pumps. In addition, a large pocket of engine oil, probably from a corroded oilcan, spilled into the floodwater and covered the remaining deposits in a thick coat of black oil. This made working conditions difficult and hindered clear inspection of deposits. It also meant that further decontamination processes were required. Floodwater was processed through a filtration system and removed from site by water tanker and debris was double bagged before disposal.
- 2.1.4 The machine pit rope chamber was not fully excavated due to concerns over structural instability and subsidence of both the rope chamber and the adjacent void. The basement sump was not fully excavated due to the considerable depth of the confined space and difficulties with floodwater. These lower deposits therefore remain *in situ*.
- 2.1.5 All finds in poor condition were photographed and catalogued before disposal as asbestos contaminated material. Diagnostic and important architectural and heritage items were decontaminated by Phoenix Asbestos Removal Ltd and retained *on-site* for C&CS and Cadw. All finds were photographed, and examples of each finds type can be found in Appendix II.
- 2.1.6 Following the debris removal, Phoenix Asbestos Removal Ltd carried out a deep clean of the basement and machine pit areas. An archaeological building survey was then carried out in these areas, in the form of measured elevation drawings, to complete the archaeological record of these newly uncovered phases of the building.
- 2.1.7 The watching Brief was carried out to the standards of the *Chartered Institute for Archaeologists Standard and guidance for an archaeological watching brief (published 2014)* and historic building record undertaken to the Standard and guidance for the archaeological investigation and recording of standing buildings or structures (published 2014).

## 3. Results

### 3.1 Stratigraphical Evidence

#### 3.1.1 Basement (Figures 7-8)

3.1.2 Accessed through a doorway at ground level on the east side of the building. There is an additional entrance into the basement on the south side but this was blocked with a steel shutter.

3.1.3 The main basement [105] and adjacent stairwell [106] contained an even spread of c.30cm depth of building demolition rubble well mixed with modern plastic and glass rubbish including packaging, bottles and stripped electricity cables (101) (Plates 9 and 10). The deposit was made up of a matrix of grey-black ash brick rubble and brick dust and humic material resulting from rotten timber and natural organic matter. Inclusions predominantly grey-black Vivian patent ash brick fragments of all sizes including a large number of whole bricks; cement mortar and cement render fragments; moderate amounts of small fragments of slate and small fragments of quarry tile including some whole tiles. Occasional amounts of modern red brick fragments including whole bricks and some whole orange foam insulation bricks. Some well-rotted and un-diagnostic timbers and occasional diagnostic pieces recovered including remains of the staircase (Plates 43 and 44, Figure 10).

3.1.4 Metal finds consisted mainly of nuts, bolts and metal plates, all in poor corroded condition, which is consistent with the import of demolition material and waste from the surrounding industrial site.

#### 3.1.5 *Basement Sump [103]*

3.1.6 The void was partially visible prior to excavation and was uncovered after removal of debris material (101) (Plate 10-14).

3.1.7 The brick-lined sump [103] contained further demolition material (102) consisting of modern rubbish including the well-rusted remains of two large modern oilcans and a large enamelled industrial light fitting. The backfill was predominately made up of a large number of whole bricks including Vivian ash bricks and a wide variety of other stamped types including yellow Nettle and red Charles Davidson & Co Adamantine refractory bricks. These appear similar to the bricks used in the latest phase (3) of repair/ alteration of the Vivian Engine House. It also contained the remains of timber boards originally used to cover the sump.

3.1.8 The excavated sump measured 1.28m x 1.16m and was excavated to a depth of 1.65m but not bottomed due to issues with water ingress. Located within the immediate threshold of the east door of the basement, the sump was lined with Vivian ash brick and was originally covered by a series of timber floorboards that were supported at one end by a purpose-made recess in the floor brickwork and at the other a supporting steel joist. Two of these floorboards remained *in situ* (measuring 25cm x 130cm x 2cm) although are in poor condition. The sump itself extends beyond the south wall of the building, where a large pennant stone block acts as a lintel, and terminates at a brick wall. Within this recess beyond the lintel a large gauge water pipe is visible with an L-shaped bend and what appears to be a valve attached. It was considered to be unsafe to investigate this further due to concerns over stability beyond the stone lintel.

3.1.9 The sump was not fully excavated due to water ingress and safety concerns, the lowest deposits were not investigated and the full nature of this feature remains unclear.

#### 3.1.10 *Basement Culvert [104]*

3.1.11 Extending east beneath the east doorway threshold, brick-lined sump [103] opens into a west/east aligned culvert [104] measuring 0.77m wide that is lined on both sides with pennant stone topped with two courses of ash brick that support a concrete slab roof (Plates 14 and 15). The south wall of this culvert appears to be aligned with the Phase 1 wall recorded at the west end of the basement. Excavated to about 1.55m length, at which point the culvert had been blocked up with timber and brick with a land drain laid in the top, which could be seen to continue eastwards beyond the current work area.

3.1.12 The culvert was backfilled, along with the sump, with demolition rubble (102) mixed with a large number of whole bricks including ash bricks, Nettle and Adamantine examples.

#### 3.1.13 Machine Pit (Figures 7 and 9)

3.1.14 The machine pit was accessed through an opening at present ground level in the east wall of the building. This opening was made in the 1980s in order to remove machinery from the building. It is also accessed from above, as it is open to the level of the machine floor. It consists of the wheel pit [206] and adjacent inspection platform [207].

3.1.15 The upper level of the machine pit debris (201) overlay the wheel pit [206] and inspection platform [207] (Plate 16). It contained an even spread of building demolition material mixed with modern rubbish, including crisp packets and bottles, to a depth of 0.75m (201). This demolition material was made up of grey-black ash brick rubble, ranging in size from grit to whole bricks, and humic material originating from rotten timber and intrusive organic matter. Within this material there was a significant quantity of cement mortar and cement render fragments, quarry tiles ranging from small fragments to whole tiles, small fragments of slate, and medium to large pieces of concrete slab. Also included were a moderate amount of well-rotted and un-diagnostic timber, as well as sections of timber roofing batten, sections of window frame and painted tongue and groove boards, all in poor condition. One long timber measuring c. 2.5cm in length and painted white may have originated from the roof. Due to the poor and well-decomposed condition of the timber no dimensions were retrievable.

3.1.16 This material is consistent with the gradual decay of the building, with the material falling or being swept into the machine pit from the machine floor. However, the amount of material is too much to have originated from the Vivian building alone, which leads to the conclusion that the wheel pit must have been deliberately backfilled with a mixture of debris from the Vivian building and material from elsewhere on the Hafod site. This must have occurred following the opening made in the east wall in the 1980s, perhaps as a health and safety measure.

### 3.1.17 *Wheel Pit*

3.1.18 At the base of the wheel pit demolition layer (201) a series of large sections of concrete slab (202) were uncovered situated within the western end of the wheel pit [206] adjacent to and on a level with the inspection platform [207] (Plates 17 and 18). These slabs were of filler joist construction with iron bar reinforcement and are identical to the machine floor slab and the remains of the yard slab outside the eastern end of the Vivian building.

3.1.19 The slabs were not laid as a surface; they were upside-down, broken up and clearly re-deposited. It was initially thought that they might have originated from the roof of the inspection platform, where steel girders, now cut out, are clearly visible (Figure 9; Plates 32-34). However, the construction of the slabs, with iron rails running through as a means of reinforcement do not match the dimensions of the inspection platform. Alternatively, a slab above the wheel pit itself was considered, however, there is no evidence for girders or joist hangers on the walls of the wheel pit. The slabs are therefore believed to have been backfilled into the wheel pit from elsewhere on site.

3.1.20 Beneath the slabs and below the current groundwater level was a continuation of the demolition rubble backfill (203) to the western side of the wheel pit [206] consisting of the same grey-black ash brick fragments ranging in size from grit to whole bricks with frequent cement mortar fragments, occasional slate and occasional quarry tile fragments. The depth of this deposit was c. 1.4m and bottomed onto the brick-lined base of the wheel pit (Plate 27). Unfortunately, a spillage of oil badly contaminated the remaining debris and it was not possible to identify any further detail as to its make-up (Plate 22 and 23).

3.1.21 Within the demolition material there was a variety of finds consistent with re-deposited industrial rubbish from the wider Hafod site. Nuts, bolts, metal plates, sections of pipe of various gauges, A large intricately framed timber board thought to be a wall-mounted spanner board (Plate 19, Figure 12) and a large timber trough thought to be a section of water leat (Plate 20 and 21, Figure 13) were exceptional finds. At the base of the deposit a hammered copper bowl, a well-worn copper hammerhead and a number of brass weights were also recovered.

### 3.1.22 *Rope Chamber [205]*

3.1.23 The rope chamber [205] was just visible as a void prior to excavation and was recorded on the 2002 plan, although the total extent was then unknown.

3.1.24 The feature contained a backfill of brick rubble (204), including many whole examples, of a mixture ash brick and industrial bricks, including red Adamantine and yellow Nettle examples. Other finds within the feature included a 12 step ladder, a 3 step ladder, sections of electrical conduit as well as other small metal waste objects such as nuts, bolts and nails.

3.1.25 The excavated rope chamber is on a level with, and extends east from, the brick-lined floor of the wheel pit [206] through a brick-built archway within the external east wall of the wheel pit (Plates 24-26). The walls are of pennant stone blocks, which on the south-facing elevation are a continuation of the wheel pit wall, whilst the north-facing wall is set back from the ash brick external east wall. There is a course of grey black ash brick on top of the pennant stone that supports a concrete slab roof.

- 3.1.26 A brick-built buttress abutting the south wall can be seen at the back of the rope chamber. To the north of this a further void or culvert can be seen to continue beyond the excavated space. The rope chamber would have enabled ropes from the Vivian engine to extend to the rolling mill drives located outside the engine house.
- 3.1.27 During excavation it became clear that the direction of backfill was not from the archway to the wheel pit as expected but instead from beyond the eastern edge of the concrete slab, where a further void or culvert was visible. The feature was not fully excavated due to concerns about potential subsidence of the concrete slab roof and the surrounding external ground surface.

## 3.2 Building Survey

- 3.2.1 The excavated and cleaned basement and machine pit were recorded in plan and by drawn elevations. The below summary serves as an addendum and should be read in conjunction with the 2002 Cambria Archaeology (Dyfed Archaeological Trust) survey of the Vivian Engine house, which did not describe the basement levels in any detail (Appendix IV).
- 3.2.2 Main Basement [105] (Figures 7-8)
- 3.2.3 The east-facing elevation at the west end of the basement [105a] consists of regular coursed large pennant stone blocks. In the top left corner there is the opening of a long stone-lined channel/ duct through to the external west wall (Plate 37).
- 3.2.4 The north-facing elevation is distinct on either side of the south doorway. To the west of the doorway the internal wall is made up of large coursed pennant stone blocks [105b] adjoining the east-facing elevation above. In a later phase this wall has been chiselled out, presumably to widen the building, and to facilitate a substantial hole in the wall to carry a large gauge pipe. This hole is partially bricked up with masonry rubble and ash bricks. Both the north and east facing pennant stone elevations have a pink-brown mortar with ash and charcoal inclusions (Plate 37).
- 3.2.5 The south doorway and the remainder of the wall are constructed on the course of a later, wider, phase of building [105c]. The doorway is faced with ash brick topped on both sides with a pennant stone block to support a steel lintel. It has two large concrete steps to the external ground level. The remainder of this elevation features one course of large pennant stone blocks at its base topped with an irregular rubble masonry wall with occasional large pennant stone blocks and a grey black ash mortar (Plates 35 and 36).
- 3.2.6 The west-facing elevation [105d] is ash brick with grey black ash mortar in regular courses and is the external east wall of the Vivian building. (Plates 36-37)
- 3.2.7 The remainder of the internal divisions consist of ash brick in English Bond with grey cement render. The south-facing wall of the main basement [105e] features a number of modifications and repair (Plate 36 and 37). At its western end, adjacent to the pennant stone elevation, there is an access hole through to the machine pit. To the east of this is a further rectangular access hole that has been blocked with red and yellow brick and is associated with a structural iron strap located on the ceiling immediately above. This feature corresponds with similar modification within the machine pit where a steel joist has been installed. Beneath these features, at the base of the wall, are three blocked inspection holes or vents, each supported by an iron lintel or strap (Plate 39). This section of wall also has a low buttress, which is abutted by a large machine base constructed of black ash brick with cement mortar.
- 3.2.8 At the east end of the machine base the wall turns at an oblique (south-west facing) angle and features at its top a large rectangular section of red/ yellow brick repair. To the east of this the wall becomes south facing once again and has a similar rectangular section of repair blocked with red/ yellow bricks. It is possible that these two areas of modification correspond with those on the other side of the wall, within the stairwell (Plate 40).

- 3.2.9 The floor of the basement is poured concrete. At the western end of the basement there is a small steel-lined sump within the floor (Plate 38). It contains a removable vertical mesh filter and features a corrugated rubber outlet hose. At the eastern end of the basement, inside the eastern doorway, is the brick-lined sump [103] and east/west aligned culvert [104] described above.
- 3.2.10 Stairwell [106] (Figures 7-8)
- 3.2.11 The stairwell is located between the north and south doorways in the eastern elevation of the building.
- 3.2.12 The south-facing wall of the stairwell [106a] has a rectangular area of repair to the top centre that is blocked with red/ yellow bricks (Plate 40). The upper 3 courses of the wall are rebuilt in the same bricks to support 3 wooden joists. There are two holes in the brickwork that correspond with the position of the two steel tie bars attached to the remains of the staircase. At the base of the wall there are two blocked inspection points/ vents.
- 3.2.13 The north-facing wall of the stairwell [106c] also has two rectangular sections of repair blocked with red/ yellow bricks and is topped with three courses that support 4 timber joists. At the base of the wall there are a further two blocked inspection points/ vents directly opposite those on the north wall.
- 3.2.14 The east-facing wall of the stairwell [106b] features a brick arched recess at floor level, identical in construction to those in the adjacent machine pit. Within it there are two further blocked inspection points/ vents, one on both north and south sides. This recess is buttressed on either side of the opening. On the left side, immediately above the buttress, there is an oblique face that has been blocked by the repair work on the north-facing wall [106c]. Above the recess the original ash brick has been modified, using yellow brick and cement mortar, forming two angled slots to take the timber staircase. The original profile of this elevation prior to this modification is unclear.
- 3.2.15 The stairwell is completed on its south-facing side with an east-facing return [106d] and a recessed south-facing wall [106e] that meets and abuts the ash brick external east wall already labelled [105d] (Plate 41).
- 3.2.16 The floor of the stairwell area is poured concrete but where a corner has broken off near the east doorway it appears that there may be a brick-lined floor beneath.
- 3.2.17 Machine Pit (Figures 7 and 9)
- 3.2.18 The excavated machine pit consists of an inspection platform [207] on its west side and an adjacent wheel pit [206] that leads to a rope chamber [205] through a brick archway in the base of the eastern external wall.
- 3.2.19 *Inspection Platform [207]*
- 3.2.20 The inspection platform has walls of grey black ash brick with cement mortar (Plates 31-34).
- 3.2.21 The east-facing elevation [207a] has a chute feature running east/west from the machine floor into the inspection platform. To the right of this is an indent for a light fixture (Plate 34).

- 3.2.22 The north-facing elevation [207b] contains three segmental brick arched recesses at its base, each containing a blocked inspection point/vent at its rear (plate 32-34). The elevation also features a number of cut-off steel pins running in a horizontal line above the brick-arched recesses, which are likely to be fixtures for electrical conduit pipe. There is an access hole through to the basement in the location of the chute in the east facing elevation. To the left of this there is an additional rectangular access blocked with red brick infill. At the top of the wall there are four evenly spaced cut off steel girders held in place with red brick infill.
- 3.2.23 The south-facing elevation [207c] has four evenly spaced cut off steel girders fixed with red brick infill that match those on the north facing elevation. It has a narrow buttress running along the length of the wall stopping short of wheel pit [206]. To the east of this, straddling the edge of the inspection platform and the western edge of the wheel pit is the brick-arched opening to an access tunnel that contains built-in iron rungs that extend up to an opening in the machine floor. This access tunnel backs on to the rubble masonry external wall of the building (Plate 31).
- 3.2.24 *Wheel Pit [206]*
- 3.2.25 The south-facing elevation of the wheel pit [206a] consists predominately of large, coursed pennant stone blocks in black ash mortar (Plate 28 and 29). Whilst the stone blocks are well-dressed they are not all of a regular size. The coursing is quite roughly built and gaps are filled and levelled in places with slate and tile fragments. Above the pennant stone the wall is made up to machine floor level with grey black ash bricks bonded with grey cement mortar.
- 3.2.26 The north-facing elevation [206b] is constructed of ash bricks that appear to be bonded with black ash mortar up to the level of the inspection chamber and above this bonded with grey cement mortar. These elevations terminate at, and are open to, the machine floor above.
- 3.2.27 On the west-facing elevation [206c] the wheel pit extends into the rope chamber [205] via a brick-built archway in the external east wall [105d]. Above this there is a modern opening in the wall that originally was ash brick elevation up to the machine floor, where an *in situ* lintel shows that there was a window opening at machine floor level, probably to carry ropes from the wheel.
- 3.2.28 On its east-facing side [206d] there are five steep, narrow steps leading down to the base of the wheel pit from the inspection platform floor that are c.40cm in height and constructed of pennant stone blocks corresponding with the stone courses on the south-facing wall [206a]. The wheel pit has a total depth from the inspection platform [207] of 1.88m.



## 4. Discussion

- 4.1.1 The results of the Vivian Engine House watching brief agree with the phasing set out in the 2002 survey plan produced by David Percival for RCAHMW and reproduced in Appendix 3 of Cambria Archaeology's 2002 Report (Appendix IV), with an additional Phase of modification and repair, which perhaps represents the conversion of the engine house to a compressor house in the 1940s.
- 4.1.2 Shortly after the completion of the watching brief outlined in this report, the original northwest corner of the Phase 1 engine house and a masonry 'dog-leg' extension were discovered surviving within the fabric of the chamfered corner of the current building. Further details of this discovery are recorded in Mann Williams' report which has been reproduced in Appendix V.
- 4.1.3 Phase 1 (1862/1863)
- 4.1.4 The Pennant stone block wall [105a] at the western end of the basement is the earliest phase encountered during the watching brief. The wall is well built and appears to be in its original form. It is most likely that this wall forms part of the 1862 foundation. However, it is tempting to suggest that the lower five courses could be the remains of an earlier building and that the 1862 wall, which is slightly inset at the level of the sixth course, is constructed on top. This is on the basis that the blocks are larger and more regular in size compared to the Western elevation of the 1862 building. There is also an apparent difference in mortar with the pennant wall mortar being pinker in colour and the external wall mortar being more yellow. Stephen Hughes writes that "part of the engine house of the 1842 rolling-mill at the Hafod Copperworks survives within the northern of the two extant engine houses" and this internal elevation may be part of that survival.
- 4.1.5 Whilst little of the remaining 1862 engine house remains other than its well-dressed western elevation, we can gain a clear understanding of the building and the engine it housed from detailed technical drawings held in the Neath Abbey Ironworks archives. The sheet entitled 'Masonry for the Hafod 24 inch diameter 3ft Stroke Vertical Engine Sep 26 1863' details an engine house with a footprint of 21ft x 9ft 3 inches (6.4m x 2.8m) (WGA D/D NAI M/4634-113) (Plate 1). The technical drawings of the engine itself describe a 24 inch cylinder 3 feet stroke High Pressure beam engine for Messrs Vivian and Sons Hafod. Neath Abbey Sept 19 1863 (WGA D/D NAI M/463/108 – 112 and 114) (Plates 2-5). The drawings are incredibly detailed and are worthy of further study. Interestingly, the drawing of the beam engine is marked in pencil with 'Not made thus' indicating that some alterations were made in the design/ construction process.
- 4.1.6 The Neath Abbey Ironwork Archives also hold drawings entitled 'Design for a pair of 23 inch engines 3ft stroke for a yellow metal rolling mill Dec 18 1858' (WGA D/D NAI M/728/21) (Plate 6) as well as drawings for the 1818 engine (WGA D/D NAI M/463/7, 25-26 and 34), drawings for a 40" engine dated to 1847 that possibly precedes the Vivian engine house (WGA D/D NAI M/463/77, Cambria Archaeology 2002, p22) (Plate 7) and many other machinery parts made for the Hafod works.

#### 4.1.7 Phase 2a External (Between 1910 and late 1920s)

4.1.8 The remaining external walls of the Vivian Engine House are a result of the enlargement of the building believed to be in order to accommodate larger machinery and a gantry crane, probably in the early 20<sup>th</sup> century (Phase 2). These take the form of rubble stone walls with occasional reused Pennant stone blocks on the north and south elevations and an eastern wall constructed of Vivian ash bricks with black ash mortar.

4.1.9 The hole punched through the wall in the south-west corner of the basement is believed to be dated to this phase as it is partially bricked up and consolidated with ash brick and black ash mortar. It is suggested that this is for a boiler flue (Cambria Archaeology 2002, p55). Here also the Pennant stone wall [105b] is rather brutally chiselled back to align with the wider dimensions. The brick-lined sump [103] and associated culvert [104] appear also to date to Phase 2, however, detailed inspection was not possible due to water ingress.

4.1.10 In the machine pit, the pennant stone wall [206a] on the north side of the wheel pit appears to have been built using reused stone and date Phase 2. The black ash mortar is similar to that of the Phase 2 external walls and its construction, at least in its upper courses, is of a relatively poor quality compared to Phase 1 elevations with tile and slate used in places to level odd-sized blocks. This wall extends into the lower rope chamber [205], which is also considered to be of the same phase of construction. In addition, the rope chamber appears to abut the expanded eastern wall.

4.1.11 The pennant stone steps to the wheel pit [206d] and the pennant stone floor of the inspection platform [207] respect the courses of the adjacent pennant stone wall [206a] and are therefore believed to date to the same phase. The brick-lined floor of the machine pit was not inspected due to water ingress but it is also believed to be Phase 2.

4.1.12 The opposite wall of the wheel pit the ash brick wall [206b] appears to have black ash mortar up to the level of the inspection platform and could tentatively be described as Phase 2 up to this level. However, the coursing is identical to the brickwork above, which has grey cement mortar and is dated to Phase 3 in the 2002 survey. Due to the poor conditions at this lower level due to water ingress and oil contamination detailed inspection was not possible. A more detailed mortar analysis would be helpful to study this further.

#### 4.1.13 Phase 2b Internal (Between 1910 and late 1920s)

4.1.14 The internal walls of the basement area are marked as Phase 3 on the 2002 plan (DAT 2002) but really relate to the second phase (Phase 2b) of development of the building. The walls are characterised by ash brick and grey cement mortar. The layout of these walls separates the basement, stairwell and machine pit. At this point the pennant stone wall [206a] in the wheel pit is raised up and it is probable that the concrete machine floor was installed at this time. The *in situ* machine slab in the basement is also constructed of ash brick with cement mortar and may have been constructed around the same time.

- 4.1.15 Phase 2b also includes the three brick-arched recesses off the inspection platform [207] and a further one in the stairwell [106b]. The purpose of these recesses is not yet understood but they may have accommodated parts of the engine machinery with (now blocked) inspection holes/ vents at the back of each one (*Pers. Comms.* Tom Henderson March 2019).
- 4.1.16 It is likely that Percival's (2002, Appendix IV) 'Phase 2' and 'Phase 3', whilst distinct in character, are two phases of the same development with the overarching objective of expanding and repurposing the building. If so, the use of cement materials for the internal works would place the renovation works in the 1920s.
- 4.1.17 A map dated to 1910 that illustrates the 'Proposed Railway Connection' through the Hafod Copperworks (RBA LAC/126/C11) is held by the Richard Burton Archives (Figure 2). The nature in which the building was expanded, with its angled north-west corner, suggests that it was built within a confined space, probably bounded by this railway. The map then, provides a useful antedate for the Vivian Engine House expansion.
- 4.1.18 A series of aerial photos held by the National Museum of Wales and dated to the 1920s show the Vivian Engine House in its present form and surrounded by rolling sheds. The railway can also be seen running through the Hafod site (NMW 75.64I/10-20) (Plate 8). This photograph therefore postdates the expansion. The archival evidence is therefore in agreement with the archaeological evidence for a probable 1920s construction.
- 4.1.19 No archives were found during our research relating to the type of engine for this expanded building and this is an area for further research. However, a very detailed plan of Hafod Copperworks is held by Swansea Museum, which is undated but was produced by ICI Ltd so must have been drawn after 1928 (Figure 3). It shows the expanded Vivian Engine House labelled as the 'New Mill Engine House', which would have been accurate considering that the Musgrave Engine House was completed in 1910. Here the engine is clearly marked along with its rope drive and rolling mills. The course of the railway track past the building is also marked. Also of note, is the conveyor pipe directing water from the canal basin, west of the engine house, to the adjacent boiler house.
- 4.1.20 A later ICI plan held by Swansea Museum (labelled as 1951 but this seems to conflict with the 1945 plan) (Figure 4), which shows the engine houses in less detail but illustrates an outlet pipe from the now former canal basin directing canal water to both the Vivian and Musgrave engine houses. In fact the water appears to channel through the culvert [104] (Figures 7 and 8) uncovered during the watching brief and continue through the copperworks in a complex network of culverts or pipes. The outlet pipes are labelled "CW" which is presumably 'canal water' or 'clean water' and further pipes are labelled "DW" which is presumably 'drain water' or 'dirty water'.
- 4.1.21 This detail is a reminder of the importance of water supply for the operation of the Copperworks, an engineering feat that is worthy of further research. The technical drawings held in the Neath Abbey Ironworks Archive illustrating 'Wrought iron pipework for conveying water from canal to the works for Messrs Vivian and Sons (WGA D/D NAI M/788/6) and 'Pump for forcing the condensing water to the canal with cistern Nov 14 1818 (WGA D/D NAI M/728/2 and 3) indicate that Swansea Canal was providing water to the Copperworks as far back as the first engine house of 1818.

- 4.1.22 In addition to being of historical interest, a better understanding of the water channels through the wider Hafod Morfa Copperworks site would be beneficial in the long term to inform about water ingress issues, as well as potential voids, such as those encountered in the watching brief.
- 4.1.23 A 1939 ICI plan held by National Museum Wales (NMW 2011.16/1) details the Vivian Engine House, its engine, drive and rolling mills *in situ* (Figure 5). This plan was apparently drawn to mark the location of electric cables with “AC” marked in green and “DC” marked in red. The plan indicates that the Vivian Engine rolls are connected to some kind of electric drive.
- 4.1.24 Further research at the West Glamorgan Archives revealed an account dated to 1911 of a trial electrification of the sheet mills, which failed due to a miscalculation of the power required. The report suggests that the beam engine was undergoing repair at the time of this trial and was therefore perhaps nearing the end of its life. Whilst it is unclear whether the installation of electric motors in 1911 is related to the electrical detail on the 1939 plan, the failure of this trial may have triggered the decision to enlarge the engine house and install the engine detailed in the 1939 plan.
- 4.1.25 Also of note on the 1939 plan, there appears to be a further engine structure adjacent and immediately to the south of the Vivian Engine House, which is also driving the Vivian’s sheet mill rolls. Additionally, a triangular structure is located in the corner between the Vivian Engine House and the railway line. The structure appears to be labelled but is illegible.
- 4.1.26 Phase 3 (Between 1939 and 1945)
- 4.1.27 The latest phase of construction in the Vivian Engine House is a series of repairs and modifications characterised by the use of red and yellow bricks including Adamantine and Nettle examples. Areas of brickwork have been blocked or patched, the basement stairwell has been modified and the machine floor has been levelled beneath the current quarry tile and cement surface. It is likely that the staircase recovered during the watching brief was installed at this time. In addition, it is likely that that the rope chamber and basement sump were backfilled in this phase as the types of brick used in the backfill and repairs appear to be the same. This may signify a change of use from the “Engine House” to the “Compressor House”. The 1945 ICI plan (Figure 6), kindly shared by Keith Turner, illustrates the layout of the Vivian Engine House following its conversion to a compressor house. The engine, drive and rolls have been removed and two compressors have been installed. The staircase has been installed in the stairwell. An outlet pipe from the Vivian building to the Musgrave building, presumably through the hole in the basement wall, is labelled with ‘cooling water valves’. There are no details of the basement layout at this time.
- 4.1.28 Phase 4 (1980 to Present)
- 4.1.29 The Hafod Morfa Copperworks was closed by Yorkshire Imperial Metals in 1980 and the Vivian Engine House was listed in 1987. The surrounding buildings were demolished at around this time and the Vivian Engine House was cleared of machinery. The backfill deposit in the wheel pit probably dates to this time and represents a health and safety measure following the opening of the access hole in the eastern wall of the building. This has been followed by a further infill of debris caused by the general decay of the building as well as fly tipping, intrusive modern rubbish and organic matter.

## 5. Finds

- 5.1.1 The finds recovered during the course of the watching brief were confined to unstratified deposits. The material was processed and catalogued according to fabric type. The assemblage is limited to modern, mainly industrial finds consistent with the re-deposition of demolition material and discarded items originating from the wider Hafod Copperworks site. Information gained from architectural timbers is limited due to their poor condition and context within unstratified material. Due to the contaminated nature of the site no finds were removed except the spanner board, copper bowl, weights, tools and engine drive parts. All finds recording occurred on-site and a photographic archive was completed. Some insignificant finds were not photographed due to their contaminated nature.
- 5.1.2 A note on architectural timbers
- 5.1.3 Both sides of the staircase were recovered within the stairwell [106], one in better condition than the other, although both in poor condition. The stair case measured 2.85m long x 23cm wide x 7cm thick, the timbers were rough-cut unfinished pine with stair slots crudely hand cut with drill and chisel; chisel marks were visible. One timber board recovered from the vicinity of the stairwell appeared to be the correct dimensions for a stair step, with a thickness of 3.5cm, whilst the remainder of the material was too badly rotted to determine. The distance between the slots in the masonry of the stairwell, representing the width of the staircase, is 64cm (Figures 7 and 8, and Plate 40).
- 5.1.4 Timber window frame sections were recovered that are consistent with existing ocular window openings (Plate 47 and 48). These consisted of quarter circle timber sections, four of which made a complete frame. The glass frame sections, all in very poor condition, showed evidence of caulking as a means of fixing the glass into the frame, at least in their latest phase. Interior faces were painted white. Two fragments featured elements of a brass window catch (Plates 49 and 50, Figure 10).
- 5.1.5 There is one *in situ* ocular window frame (Plate 51) that has a catch hook fixture at its top informing us that the window would have clasped at the top and opened inwards. This *in situ* window frame also reveals the method of construction with internal and external frames being each constructed of four quarter-circle sections and then offset and secured with two bolts at the join. No obvious bolts were recovered.
- 5.1.6 Small number of windowpane components that may represent elements of existing rectangular openings but uncertain due to un-stratified nature of backfill (Plate 52). Window frames fragments with identical profile can be found as debris elsewhere on the Hafod-Morfa site.
- 5.1.7 A total of 11 lengths of white painted tongue and groove pine timber majority in poor condition and rotten at edges with dimensions of 1.4m x 19cm x 2cm (Plates 45 and 46). These timbers may originate from a timber Vivian Engine House roof, and if so the unpainted ends would suggest that they were fixed at their ends immediately behind steel joists before being painted internally. However, their position in un-stratified deposits means that we cannot be certain of their origin, particularly considering the nature and scale of the re-deposited material that must have come from the wider Hafod site.

**Table 1. Finds Inventory**

ID	Context	Material Type	Fabric type	Quantity	Period	
1	(101)	Iron		1	Modern	Small iron cart wheel 12cm diameter
2	(101)	Steel		1	Modern	Spanner 28 x 4cm
3	(101)	Wood	Window frame	5	Modern	Window frame – circular
4	(101)	Wood	Stair component	1	Modern	1 x fragment of stair step. Untreated pine. Very poor condition with rotted ends but has dimensions of 18.5cm width x 3cm deep. Length estimated at c. 66cm according to slots in stairwell brickwork.
5	(101)	Wood	Stairs	2	Modern	2 x stair strings. Both well rotted and in very poor condition. Untreated pine. Crude construction. Top and bottom ends cut at c45 degree angle to enable installation. Stair slots made by hand with drill and chisel. Marks are visible. Two long steel ties correspond with holes in stair well wall. Dimensions were retrievable from one although length uncertain. c.285cm x 23cm x 7cm. 9 x stair slots cut at c. 45degree angle and measuring 23cm(outside edge)/23cm(inside edge) length x 3.5 cm width x 1cm depth. Dimensions of staircase known by slots in stairwell brickwork, which are 64 cm apart.
6	(101)	Rubber		8	Modern	8 x rubber gaskets. 15cm diameter
7	(101)/ (201)	Steel		14	Modern	14 x steel washers. 5-12cm diameter
8	(101)/ (201)	Steel		10	Modern	20mm diameter bolts with nuts and washers 8cm long
9	(101)/ (201)	Wood	Window frame	5	Modern	Window frame - circular
10	(101)/ (201)	Slate		45	Modern	Fragments of blue slate. None diagnostic. Largest 23 x 46cm
11	(101)/ (201)/ (203)	CBM	Tile	77	Modern	Quarry tiles. Red. 15 x 8 x 1cm
12	(101),(201) ,(203), (204)	CBM	Brick	641	Modern	Vivian patent ash brick. Grey black in colour. Froged with shallow-ended ovoid. Very friable. Many have cement render/ mortar attached. 11 x 23 x 8 cm.
13	(102)	Steel		1	Modern	Industrial lampshade – enamelled. 47cm diameter x 45cm

ID	Context	Material Type	Fabric type	Quantity	Period	
14	(102)	Steel		1	Modern	Highly corroded remains of large oil can 40cm diameter
15	(102)	CBM	Brick	1064 (Total for all non-patent ash brick)	Modern	'Marston' Brick. Yellow/ cream with deep frog and scratch marks on outside edge. 22 x 10 x 7cm
16	(102)	CBM	Brick		Modern	'Glenboig' brick. Creamy yellow. No frog. 23 x 11 x 7cm
17	(102)	CBM	Brick		Modern	'Copper Pit' brick (frag). Light orange. Shallow frog with rounded edges. (14) x 11 x 7.5cm
18	(102)	CBM	Brick		Modern	Un-named brick. Light orange yellow. Very shallow frog. 22.5 x 11 x 7.5cm
19	(102)	CBM	Brick		Modern	'Jones Darran No1 Risca' brick. Dark grey/ green. Stamped. Unfrogged. 23.5 x 11.5 x 7.5cm
20	(102)	CBM	Brick		Modern	'Cynghordy' brick. Orange. Stamped. Large shallow frog. 22 x 10.5 x 7cm
21	(102), (204)	CBM	Brick		Modern	'Nettle' brick. Creamy yellow. No frog. 23 x 11.5 x 7.5cm
22	(102)/(204 )	CBM	Brick		Modern	'Adamantine Davidson Buckley Made in England' brick. Orange/ yellow. Unfrogged. 23 x 11 x 7.5cm
23	(102)	CBM	Brick		Modern	Un-named brick. Red orange. Unstamped. Unfrogged. 23 x 11 x 6
24	(102)	CBM	Brick		Modern	Illegible stamp. Red orange. Deep rectangular frog. 18.5 (partial) x 11.5 x 7.5cm
25	(102)	CBM	Brick		Modern	'Best Stourbridge' stamp. Creamy yellow. Unfrogged. Stamped. 22.5 x 11 x 7cm.
26	(201)	Copper		1	Modern	Copper sheet with hole at top. 44.5 x 20cm. Very thin c. 2mm. v. contaminated with asbestos
27	(201)	Brass		2	Modern	Inset light fittings 22cm diameter
28	(201)	Brass		2	Modern	Slate nails
29	(201)	Steel		3	Modern	3 x sharpening files
30	(201)	Steel		1	Modern	Electrical switch casing 25x31cm
31	(201)	Iron		1	Modern	Box of nails. Poor condition. Box decomposed leaving corroded nails.
32	(201)	Iron		1	Modern	Fire grate

ID	Context	Material Type	Fabric type	Quantity	Period	
33	(201)	Iron		1	Modern	Ash scraper for firebox. 32 x 118cm
34	(201)	Wood		1	Modern	Part of lightweight timber door frame 68 x 175 x 3 cm
35	(201)	Wood		2	Modern	2 cupboard door panels with locks; 66 x 8 x 3cm, 66 x 16 x 3cm
36	(201)	Wood		4	Modern	4 legs from table/ stool/ bench. 54 x 5 x 5cm
37	(201)	Wood		6	Modern	Window glass frame – circular
38	(201)	Wood	Board	6	Modern	6 x Pine tongue and groove boards. Painted white with ends unpainted. Poor condition – well rotted but preserved on painted surface. 141 x 21 x 2cm, 141 x 11 x 2cm
39	(201)	Wood		2	Modern	Section of door frame 190 x 12 x 6cm
40	(201)	Wood	Roof batten	c.20	Modern	Fragments of untreated pine roof batten. Poor, well-rotted condition. Longest 157 x 5 x 2cm width brass slate nails/ nail holes c. 17cm apart.
41	(201)	Slate		1	Modern	1 x frag of slate with hole showing width of 34cm. (x 12cm)
42	(201)	Slate		16	Modern	16 x Fragments of blue slate
43	(201)	CBM	Roof tile	2	Modern	2 x fragments of grey ridge tile
44	(201)/ (203)	Steel		10	Modern	10x lengths of electrical conduit pipe. 15mm diameter. 45 – 500cm length
45	(201)/ (203)	Steel		6	Modern	6 x large gauge water pipe. 3-inch diameter. 54cm-400cm length
46	(203)	Copper		1	Modern	Ball cock 12cm d
47	(203)	Copper		1	Modern?	Copper hammered bowl 32cm diameter x 7.5cm. 1cm brass trim.
48	(203)	Copper		1	Modern	Copper hammerhead. Mushroomed ends show wear. 7cm diameter x 10cm
49	(203)	Copper		1	Modern	Copper bar 55 x 7 x 1cm
50	(203)	Copper		1	Modern	Long length of copper trim 0.5cm diameter
51	(203)	Brass		1	Modern	Brass disk. 16cm diameter x 10mm thick
52	(203)	Brass		6	Modern	Weights 1 x 7cm diameter x 9cm 1 x 10cm d x 6cm 1 x 10cm d x 10cm 1 x 10cm d x 3cm



ID	Context	Material Type	Fabric type	Quantity	Period	
						2 x 6cm d x 1cm 1 x 13cm d x 4cm
53	(203)	Brass		1	Modern	Brass bar 16x6 x 1cm
54	(203)	Brass		1	Modern	Brass disc 28cm diameter
55	(203)	Brass		1	Modern	Starter winder handle 26 x 13cm
56	(203)	Brass		1	Modern	Brass hammering chisel with stamp. 30 x 3 x 2cm "YM1552"
57	(203)	Aluminium		1	Modern	Old style aluminium food can 8.5x7.5cm
58	(203)	Steel		1	Modern	Pail bucket, crushed 32cm d x 23cm
59	(203)	Steel		1	Modern	Oil sump 25cm d x 12cm
60	(203)	Steel		1	Modern	Electrical Switchboard casing
61	(203)	Steel		1	Modern	Foot pedal mechanism for machine. 36x19cm
62	(203)	Steel		1	Modern	Oil can 32x16cm
63	(203)	Steel		1	Modern	Mortice Door Lock 10x15cm
64	(203)	Steel		1	Modern	Machine stand with 6 bolt holes 26x41x21cm
65	(203)	Steel		1	Modern	30mm diameter . Spear-shaped metal-working tool. Heavy steel bar 84cm long. Mushroomed end shows use.
66	(203)	Steel		1	Modern	Steel pipe for ?oil with bracket and U-bend at end
67	(203)	Steel		1	Modern	Expanding safety gate. Uprights 114cm high. 16 x hinged sections 62cmx0.2cmx0.2cm
68	(203)	Steel		1	Modern	Steel tube safety handrail. 32mm diameter x 3m length
69	(203)	Steel		2	Modern	Steel pipes 30mm diameter x 1m length
70	(203)	Steel		1	Modern	Steel pipe 43mm diameter x 1m length
71	(203)	Steel		1	Modern	25mm diameter a 1m length
72	(203)	Steel		2	Modern	30mm diameter jointed U-bend steel pipe
73	(203)	Steel		1	Modern	35mm diameter jointed t-bend steel pipe
74	(203)	Steel		2	Modern	35mmd Straight length steel tube
75	(203)	Steel		1	Modern	Dipstick 80cm long

ID	Context	Material Type	Fabric type	Quantity	Period	
76	(203)	Steel		1	Modern	Gate valve for 25mm diameter pipe. 12 x 14cm
77	(203)	Steel		1	Modern	Pressure valve for 25mm pipe. 19 x 21cm
78	(203)	Steel		1	Modern	55mm diameter jointed t-shaped steel ?water pipe
79	(203)	Steel		1	Modern	Steel metal-working tongs. 52 x 20 x 2cm
80	(203)	Steel		1	Modern	Steel plate. Thin. 13 x 14cm
81	(203)	Steel		1	Modern	Electricity fuse box
82	(203)	Steel		1	Modern	Large industrial spanner 70 x 8 x 3cm
83	(203)	Steel		1	Modern	Pipe bracket 40 x 4cm
84	(203)	Steel		6	Modern	Steel end cap 12 cm diameter
85	(203)	Steel		1	Modern	L-bend pipe wide gauge
86	(203)	Steel		1	Modern	Steel bar with measuring rings - ?dibber. 3cm diameter x 73 cm long
87	(203)	Steel		1	Modern	Wide gauge pipe and pipe reducer 6cm diameter x 50cm
88	(203)	Steel		1	Modern	Gate valve
89	(203)	Steel		1	Modern	Oil can. Highly corroded. 34 x 34 x 22cm
90	(203)	Steel		1	Modern	Drain cover 40 x 28 x 0.5cm
91	(203)	Steel		3	Modern	Steel toothed gasket 44cm diameter
92	(203)	Steel		1	Modern	30cm fragment of thin steel toothed plate - ?gasket
93	(203)	Steel		1	Modern	Steel ?base plate 11.5 x 24cm x 2cm
94	(203)	Steel		1	Modern	Steel cover plate with 8 holes. 21 x 23cm
95	(203)	Steel		1	Modern	Steel reducing plate for pipe with 8 bolt holes. Reducing from 6" to 2".
96	(203)	Steel		1	Modern	Steel plate 20x10cm
97	(203)	Steel		1	Modern	Heavy adjustable wrench/ calliper. 34 x 12cm
98	(203)	Steel		35	Modern	35 x bolts 20mm diameter
99	(203)	Steel		1	Modern	Padlock. 7 x 10 x 3cm
100	(203)	Steel		16	Modern	Steel plates – offcuts. 13 x 13 cm, 11 x 6cm

ID	Context	Material Type	Fabric type	Quantity	Period	
101	(203)	Steel		3	Modern	Machine brackets 60 x 6 x 0.5cm
102	(203)	Steel		1	Modern	Valve wheel 15cm diameter
103	(203)	Steel		2	Modern	Fragments of steel straps – construction. 40 x 6 x 1cm
104	(203)	Steel		2	Modern	Industrial door hinges 93 x 10 x 7cm
105	(203)	Steel		1	Modern	Pipe connector large gauge 9cm diameter x 16cm
106	(203)	Steel		1	Modern	Gate valve 10cm diameter x 13cm
107	(203)	Steel		1	Modern	Large counterweight. Forged. 30 x 30 x 15cm
108	(203)	Steel		1	Modern	Large counterweight. Forged. 10cm diameter x 25cm
109	(203)	Steel			Modern	Electric motor parts
110	(203)	Steel		1	Modern	Pulley wheel 26cm x 7cm
111	(203)	Steel		1	Modern	1 x wall tie bracket 107 x 6 x 6cm
112	(203)	Steel		3	Modern	Lengths of T-bar 4 x 4cm x 95-242cm
113	(203)	Iron		1	Modern	Iron plate 62 x 11 x 1cm
114	(203)	Iron		2	Modern	Iron rails use within concrete slab as reinforcement 8x6x183cm
115	(203)	Iron		2	Modern	2 x iron tram wheels 17vm diameter
116	(203)	Glass		4	Modern	Milk bottles. 7cm diameter x 23cm. 1 x Unigate, 3 x Coronet.
117	(203)	Leather		1	Modern	1 x pair of leather work boots with wooden clog soles
118	(203)	Leather		3	Modern	3 x pairs of leather work boots with rubber soles
119	(203)	Wood		1	Modern	Yard brush
120	(203)	Wood		1	Modern	Large ornately framed timber tool board. 2 ply of pine tongue and groove panel boards. Hexagonal pieces nailed on in a 'V' configuration to hold spanners of different sizes. Painted orange primer and green topcoat. Writing in chalk pen is visible. Overall size 2.5m x 1.8m Back boards of same dimensions with wall brackets.
121	(203)	Wood		1	Modern	Fragment of timber post with octagonal profile and a pair of holes at one (round) end. Broken where joint might have extended. 7.5cm diameter x 50cm long.

ID	Context	Material Type	Fabric type	Quantity	Period	
122	(203)	Wood		1	Modern	Length of octagonal profile timber post with jointed end. 6cm diameter x 187cm overall length (25cm joint section)
123	(203)	Wood		1	Modern	Remains of timber trestle/ saw bench. V poor condition. 95 x 66cm
124	(203)	Wood		1	Modern	Domestic timber handrail 8 x 6 x 340cm
125	(203)	Wood		1	Modern	Domestic banister upright. Turned pine. 5 x 5 x 63cm
126	(203)	Wood		1	Modern	Roof timber with chamfered edge containing nail holes that suggest battening attached. 15 x 5 x 152cm (fragment). Chamfer 3cm)
127	(203)	Wood		3	Modern	Fragments of roof timber – pine. Rounded profile. Poor condition with rotted ends. 11 x 18 x 173cm, 11 x 18 x 110cm, 11 x 18 x 110cm
128	(203)	Wood		1	Modern	Large hard wood timber section of water leat.
129	(203)	CBM	Tile	1	Modern	1 x ceramic Electricity cover tile “Danger Baldwin Electricity”. 30 x 30 x 6cm
130	(203)	Plastic		1	Modern	Blue plastic ashtray ‘Buckleys’
131	(203)	Asbestos		3	Modern	3 x Double gasket 52 x 33cm
132	(203)	Asbestos		9	Modern	9 x asbestos gasket 55cm diameter
133	(203)	Asbestos		3	Modern	3 x asbestos gasket 23cm diameter
134	(203)	Asbestos		2	Modern	2 x asbestos gasket 14cm diameter with triangular internal profile.
135	(203)	Asbestos		8	Modern	8 x asbestos scraps
136	(203)	Wood		2	Modern	2 x brooms
137	(204)	Wood		1	Modern	3-step stepladder. Pine. Rails 60 x 14 x 3cm. Top step 40 x 18 x 3cm. Steps 33 x 17 x 3cm.
138	(204)	Wood		1	Modern	9-rung timber ladder. 223 x 5.5 x 3.5cm

## 6. Conclusion

- 6.1.1 The archaeological watching brief of the debris removal from the Vivian Engine House found that the majority of the material in both the basement and the machine pit was modern backfill of demolition material and rubbish from the Vivian Engine House and the wider Hafod site. The removal and recording of items of archaeological/architectural interest was particularly challenging given the heavy contamination on-site and general poor ground and building conditions. However, the backfill material did produce a number of significant finds relating to the Copperworks, including an intricately framed spanner board, a hammered copper bowl and a section of timber leat. Architectural elements were also recovered including bricks, stairwell timbers, timber boards and sections of window frame. Whilst these may have originated from the Vivian Engine House, their position within general backfill material means that we cannot be certain.
- 6.1.2 The debris removal gave an opportunity to uncover and record the lower levels of the Vivian Engine House, the nature of which were previously unknown. In the basement a brick-lined sump and water culvert were uncovered. The wheel pit was found to have a deep stepped profile on its west side, leading from the adjacent inspection platform, and a brick-lined base. The rope chamber leading from its eastern side was surprisingly large and leads to further structures beyond the current work area. The watching brief concluded that the phasing of the building following the work agrees with the 2002 RCAHMW survey. There was no evidence that could enhance knowledge of the position or layout of the original wheel or engine machinery within the engine house, any evidence appears to have been removed or concealed by later phases.
- 6.1.3 Archival research at the West Glamorgan Archives, in particular the Neath Abbey Ironworks collection, the Richard Burton Archives, Swansea Museum Collections and National Museums of Wales Collections has uncovered further detail about the development of the building. Detailed phasing already produced of the 1862 Vivian Engine House and Engine, the c.1920s enlargement of the building and its conversion to a Compressor House in the early 1940s has been enhanced by the archival research. Evidence relating to water and electrical supply to the engines and rolling mills have also been illuminating and are areas for further research.

## 7. Bibliography

Cambria Archaeology. 2002. 'The Yorkshire Imperial Metals Site: Archaeological, Condition and Health and Safety Appraisals and Budget Costs.' Report No 2002/100.

Grant-Francis, G. 1881. 'The Smelting of Copper in the Swansea District of South Wales' from the Time of Elizabeth to the Present Day'. Henry Sotheran & Co. London & Manchester.

Hughes, S. & Reynolds, P. 1989. 'A Guide to the Industrial Archaeology of the Swansea Region'. Association of Industrial Archaeology: RCAHMW 609.

Hughes, Stephen. 2000. 'Copperopolis: Landscapes of the Early Industrial Period in Swansea'. RCAHMW.

Morgan Rees, D. 1975. 'The Industrial Archaeology of Wales'. David & Charles Inc., Newton Abbot, London, North Pomfret (VT) & Vancouver.

### Other sources

British Geological Viewer. Accessed online 09/04/19.

### Archives

National Museum of Wales Collections. Accessed online 30/04/19.

Richard Burton Archives, Swansea University. Visited 30/04/19.

Swansea Museum Collections. Visited 01/05/19.

West Glamorgan Record Office: Neath Abbey Ironworks Archive. Visited 10/04/19.

## **8. Appendices**

### **8.1 Appendix I: Figures**

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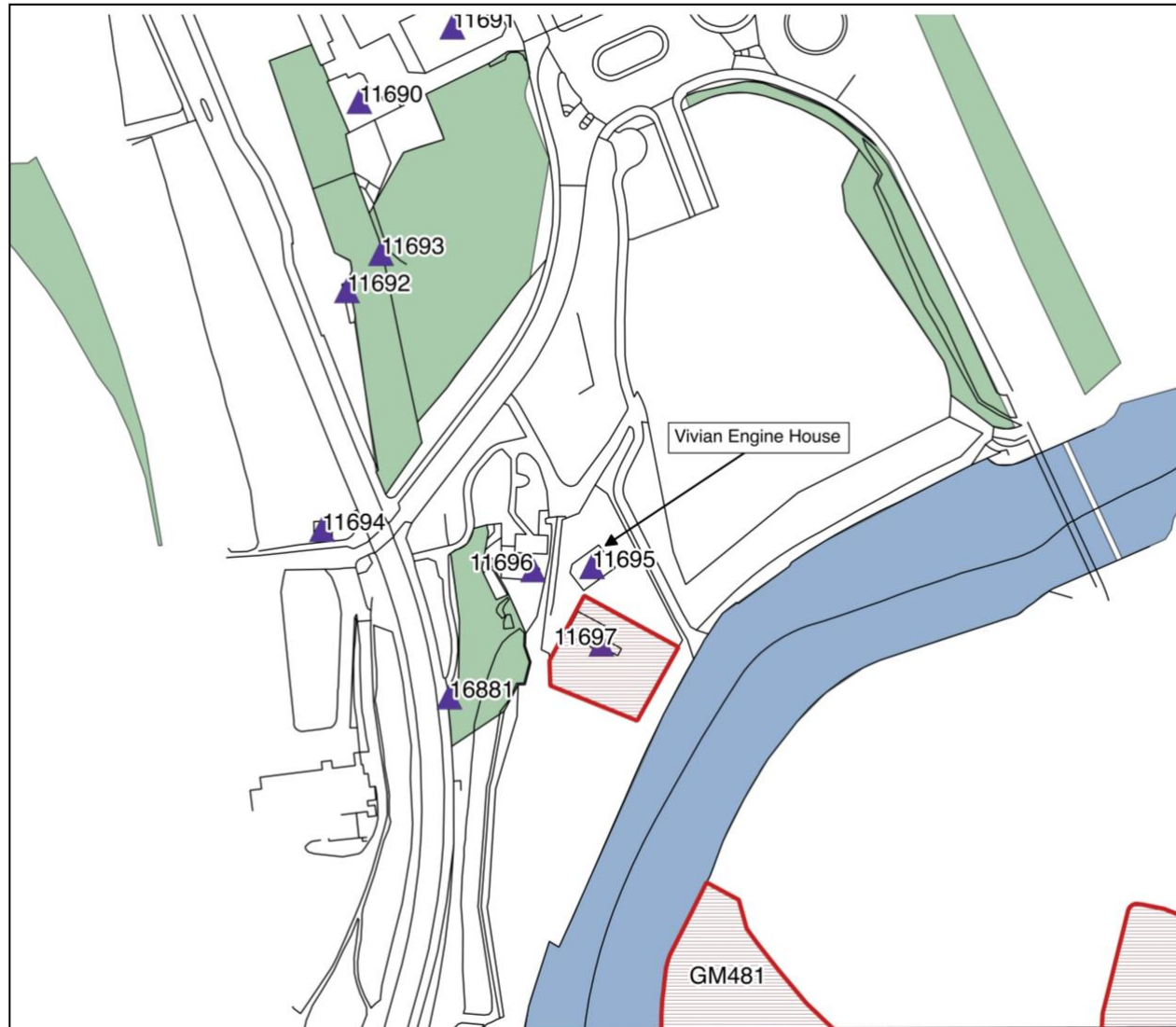


Figure 1. Plan showing the location of the Vivian Engine House. Ordnance Survey basemap reproduced under licence 100058761



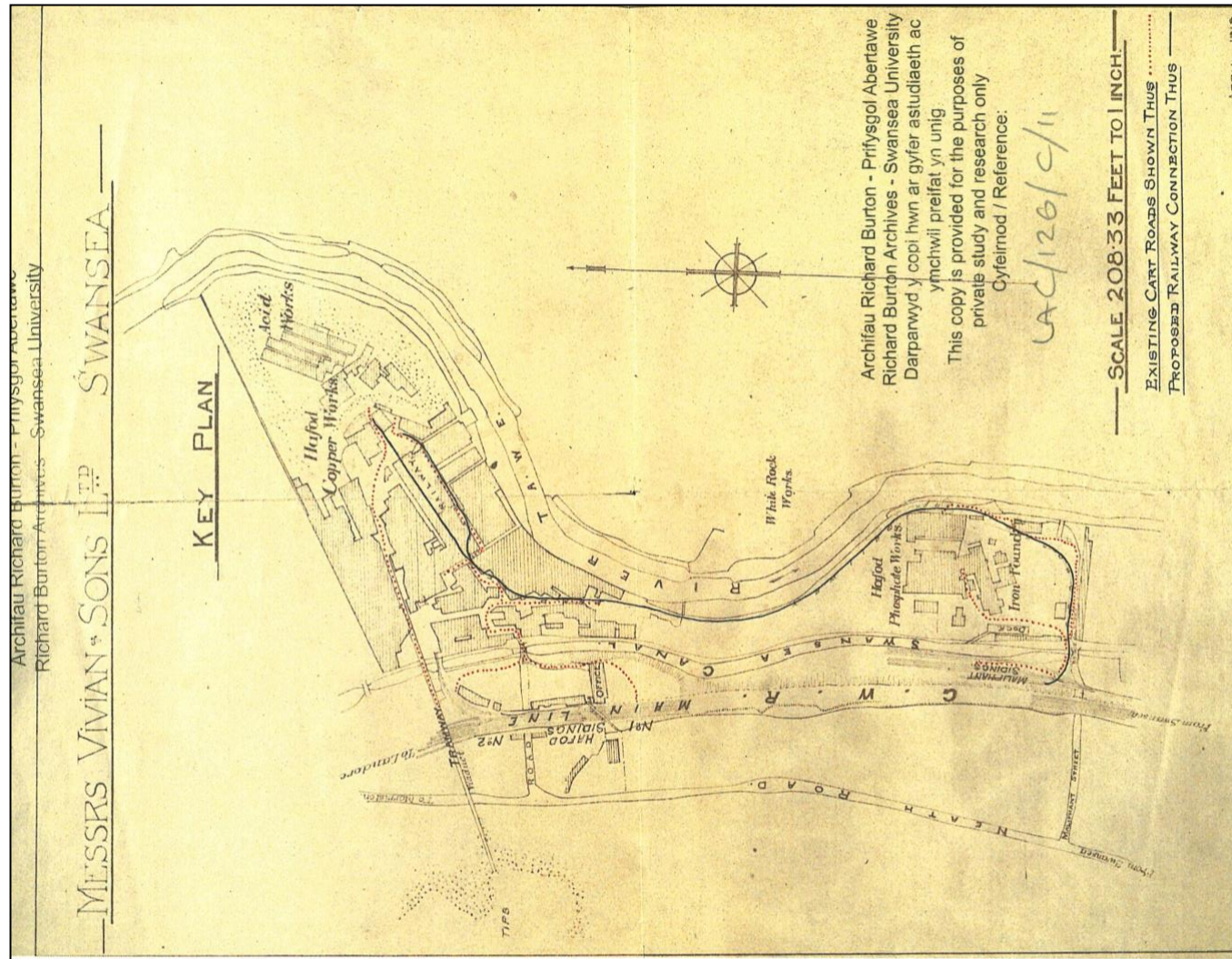


Figure 2. 1910 plan showing a 'proposed railway connection' through the Hafod Copperworks. © Richard Burton Archives



Figure 3. Detail of plan drawn by ICI Ltd and dated to c. 1928. The expanded Vivian building is labelled the 'New Mill Engine House'. © Swansea Museum Collections



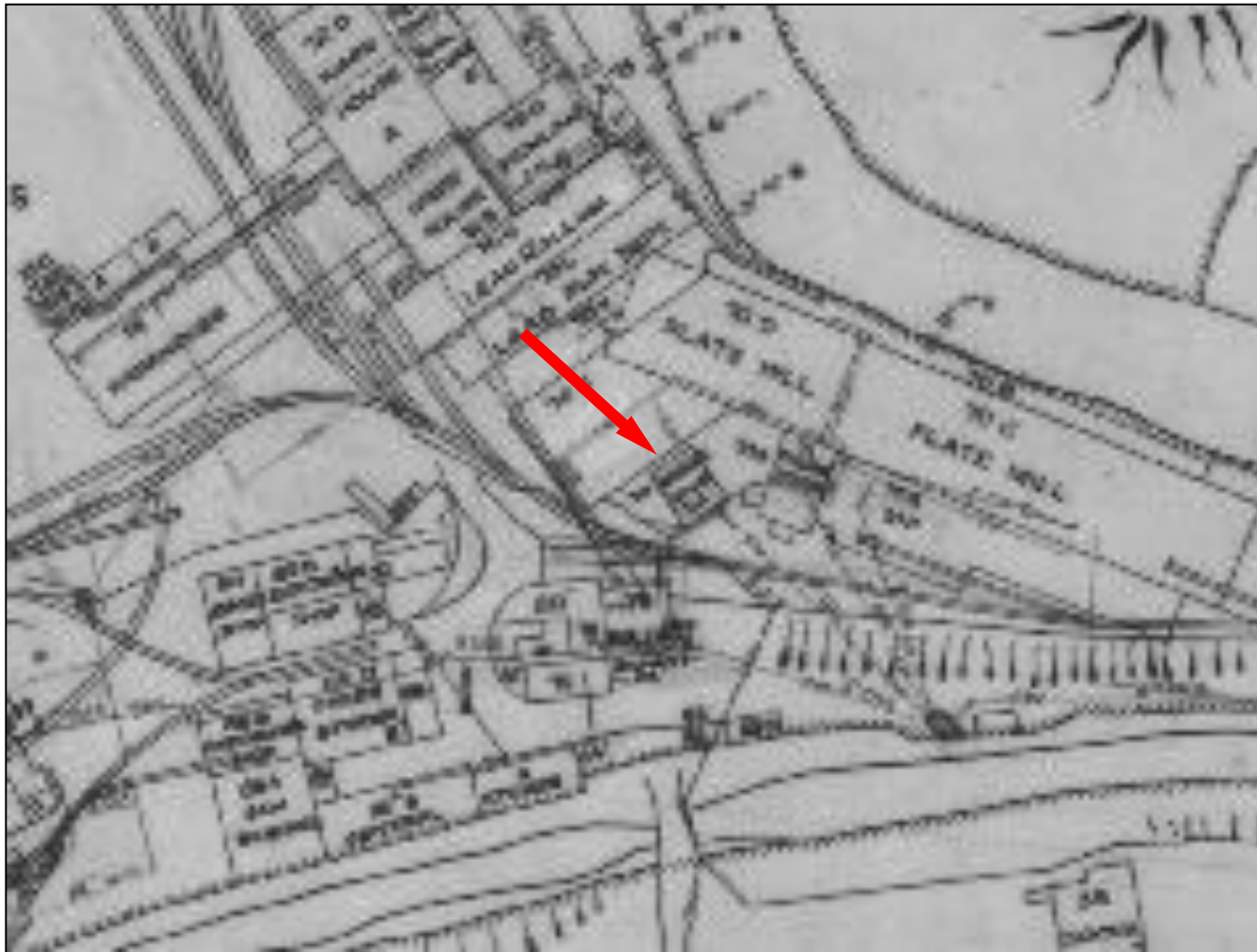


Figure 4. Detail from an ICI plan of unclear date (labelled as 1951). The outlet pipe from the former canal basin is feeding a network of pipes through the Hafod Copperworks, including the basement culvert uncovered in the watching brief. © Swansea Museum Collections



Figure 5. 1939 ICI plan of Hafod Copperworks showing the Vivian Engine House. The Vivian Engine House rolling mills appear to be fitted with electric drives. Note the additional rolling mill drive just above the Vivian Engine House in this plan. © National Museum Wales



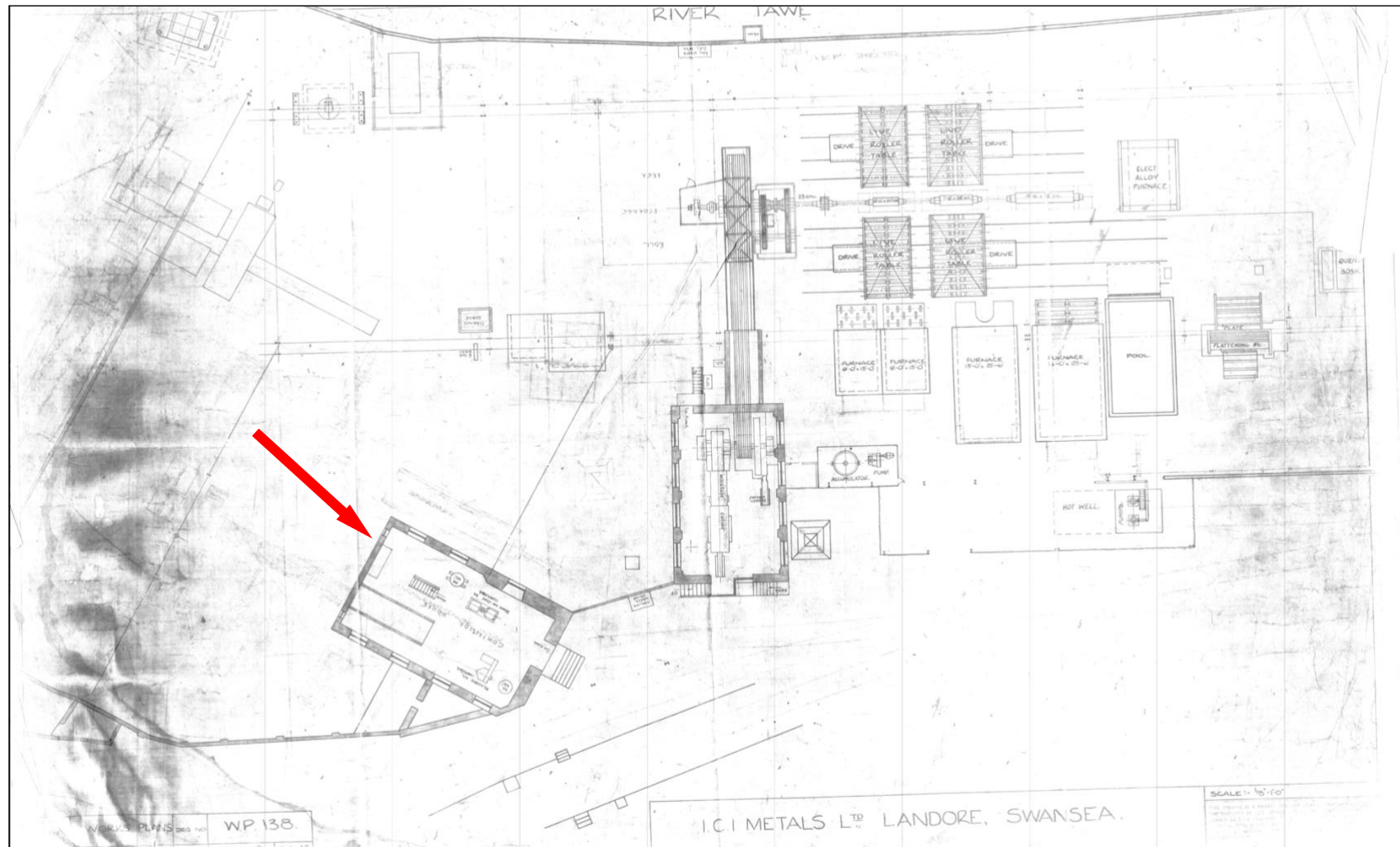


Figure 6. 1945 ICI Plan of the Vivian and Musgrave engine houses. The Vivian building has been converted into a compressor house.  
© Keith Turner

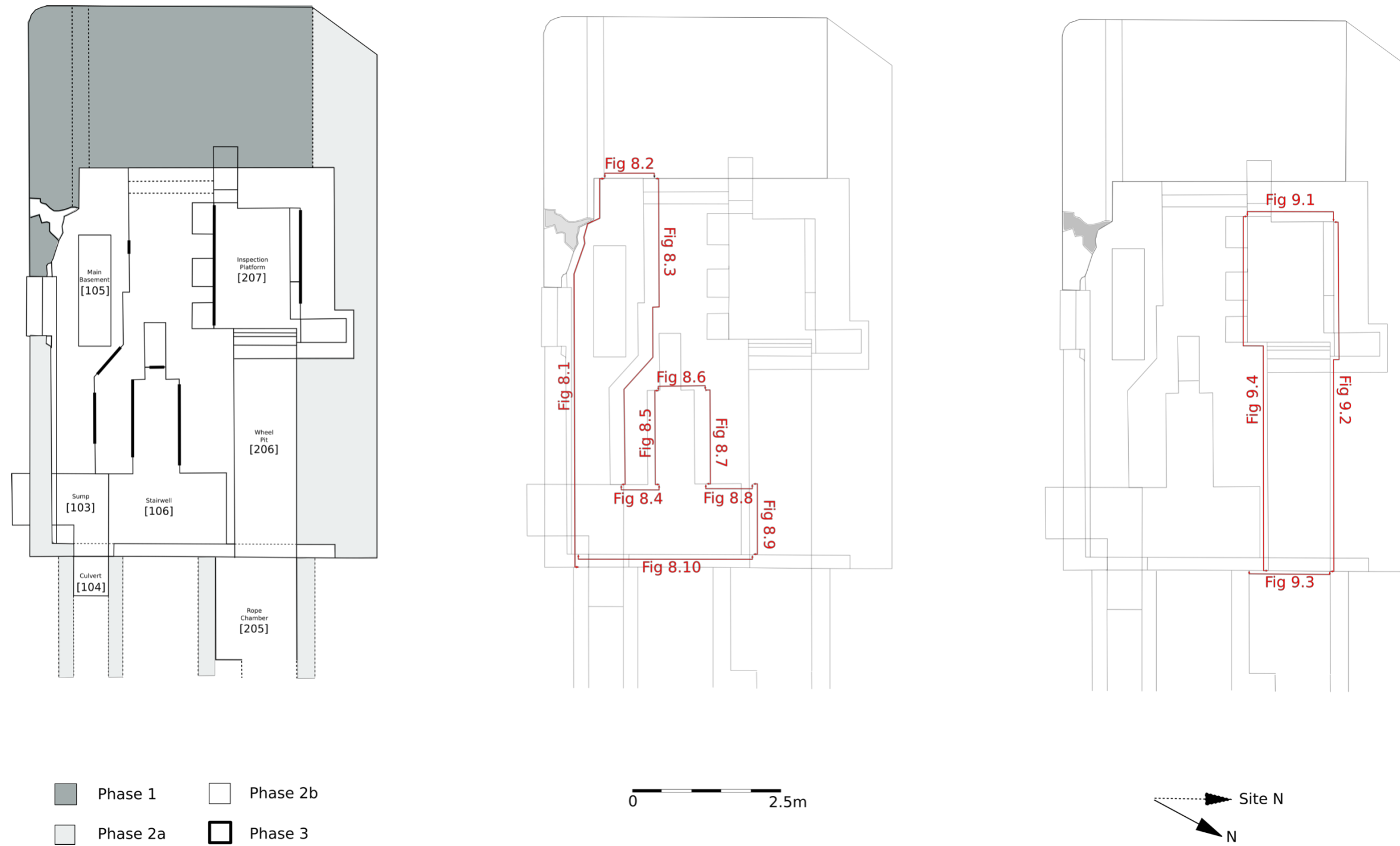


Figure 7. Updated plan of Vivian Engine House after Percival 2002 showing extent of basement sump [103], culvert [104] and rope chamber [205].

Main Basement [105]

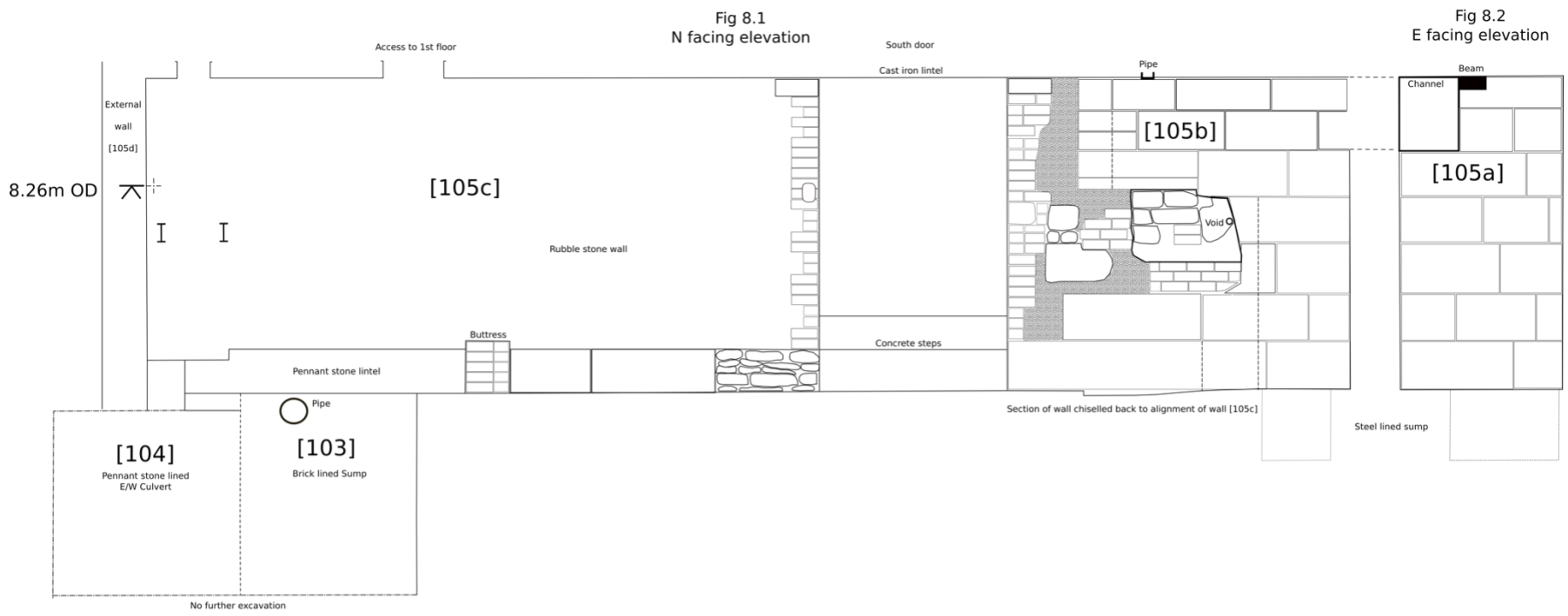
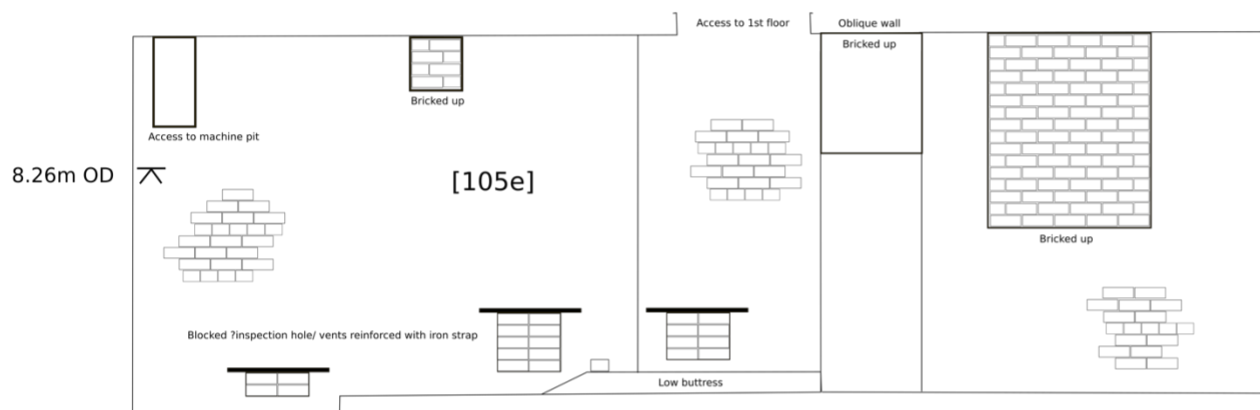


Fig 8.3 S facing elevation



Stairwell [106]

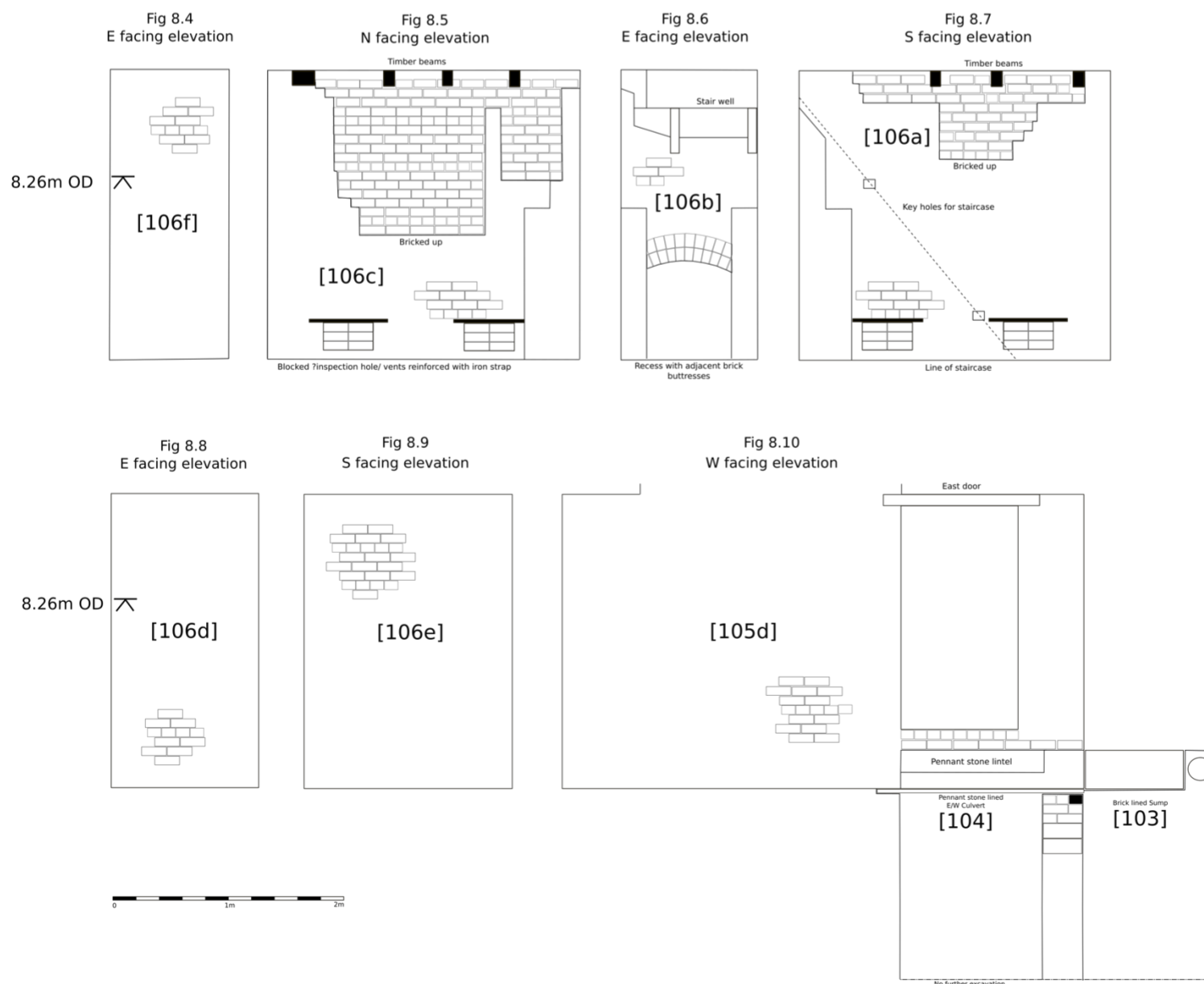


Figure 8. Elevation drawing record of the basement of the Vivian Engine House showing the main basement area [105], stairwell area [106], basement sump [103] and culvert [104].

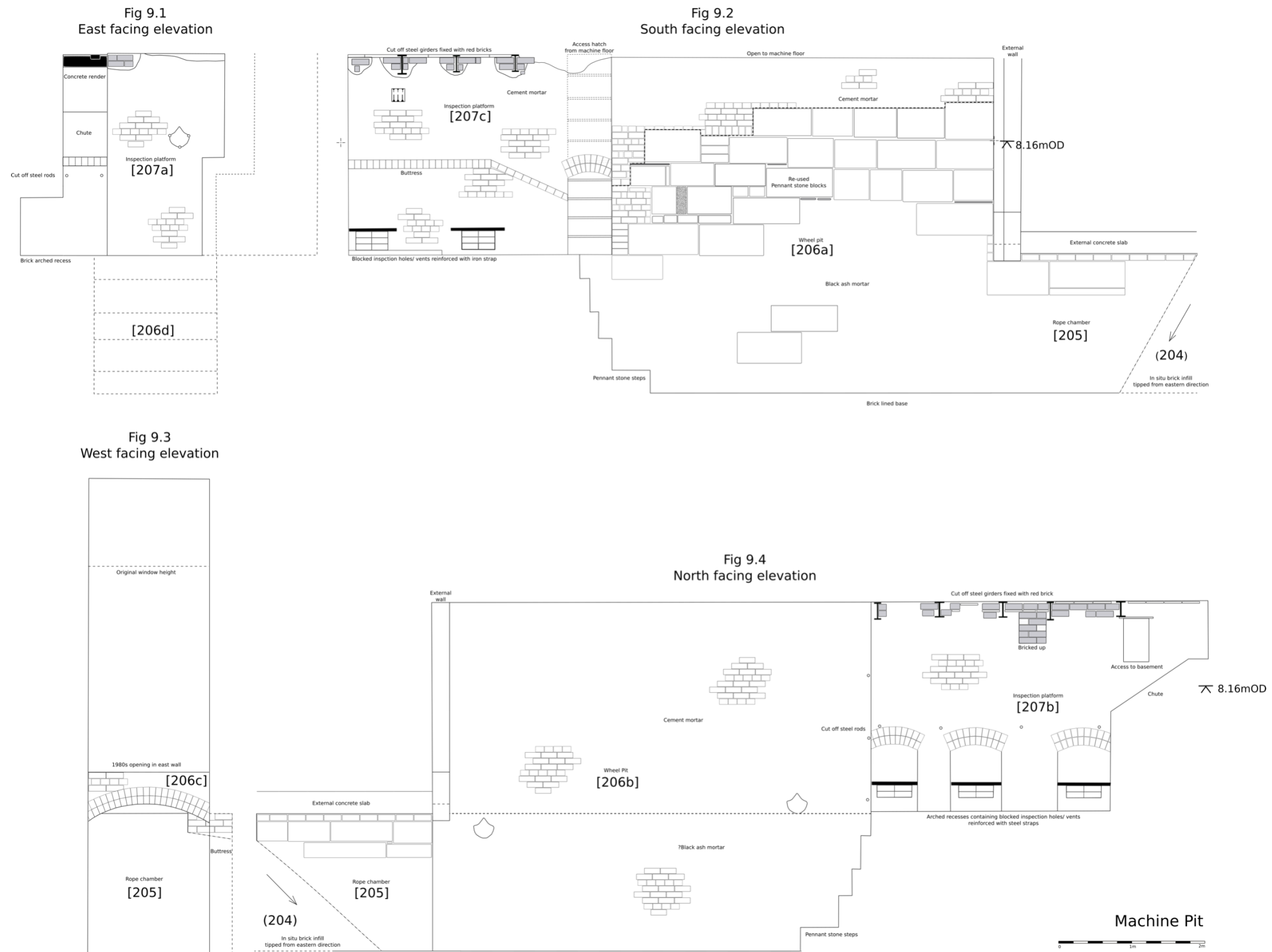
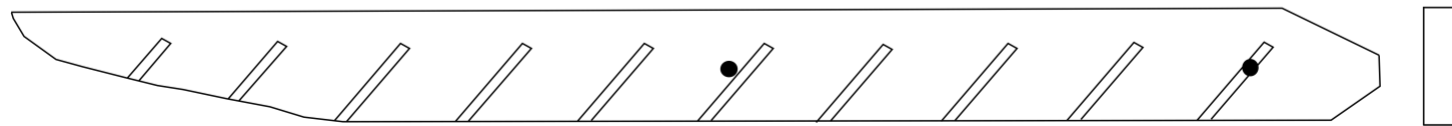


Figure 9. Elevation drawing record of the Vivian Engine House Machine Pit showing the Wheel Pit [206], Inspection Chamber [207] and Rope Chamber [205].





Measured sketch of the stair string recovered from Vivian Engine House basement  
1:20



Figure 10. Measured sketch of the stair string recovered from Vivian Engine House basement.

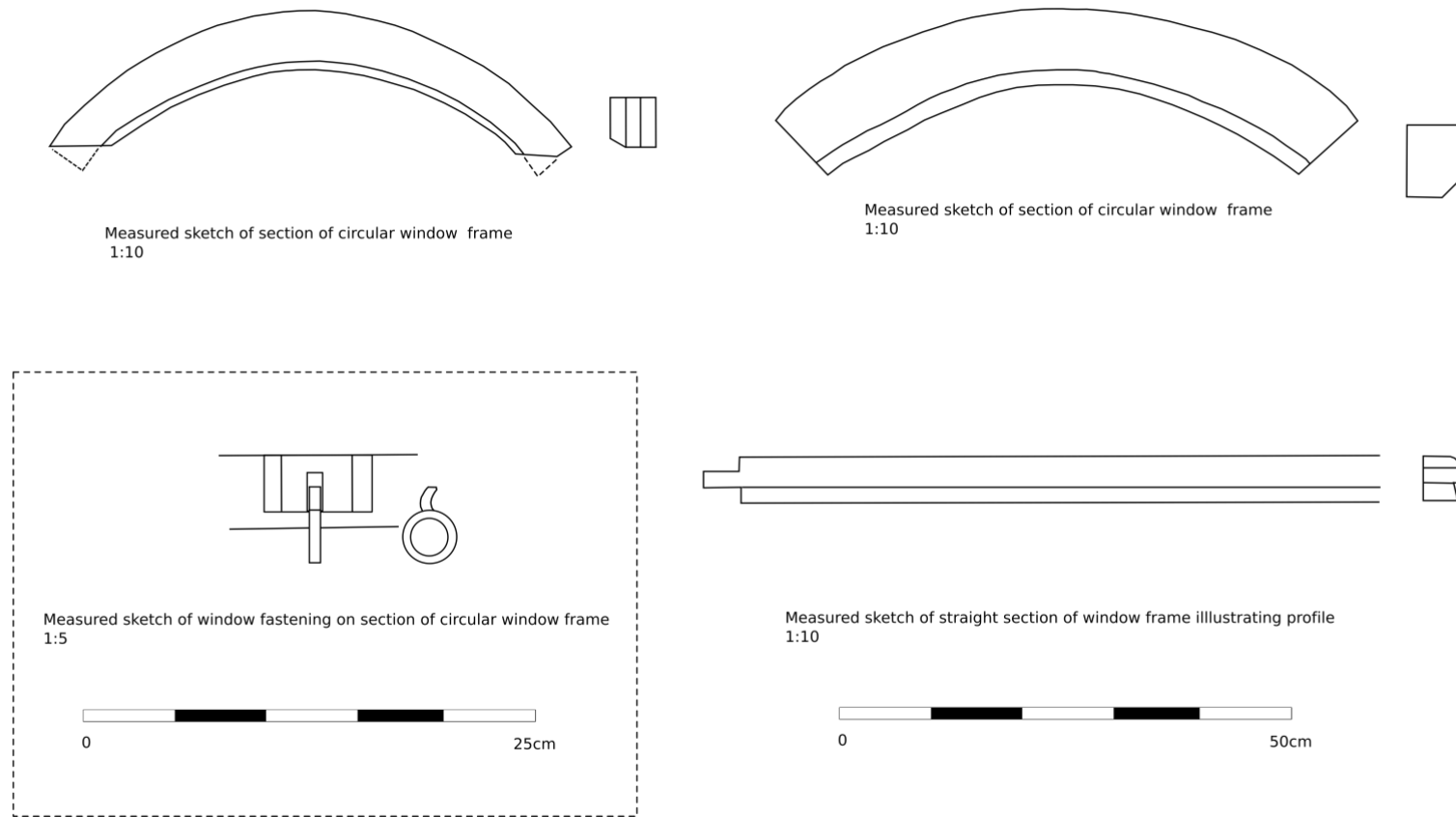
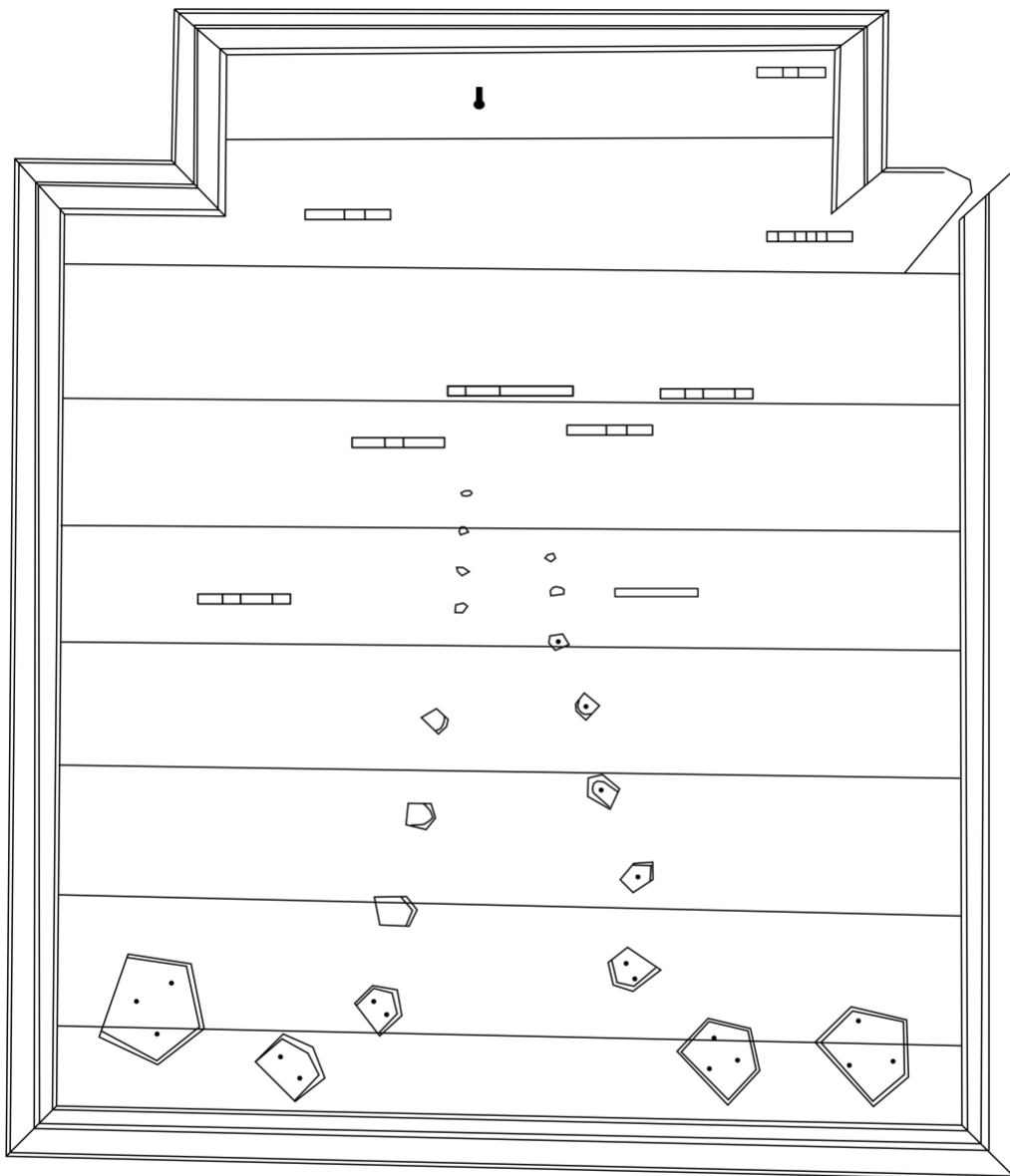


Figure 11. Measured sketches of sections of window frame recovered from the Vivian Engine House



Measured drawing of the timber spanner board recovered from the Vivian Engine House  
1:10  
0 50cm

Figure 12. Measured drawing of the timber spanner board recovered from the Vivian Engine House

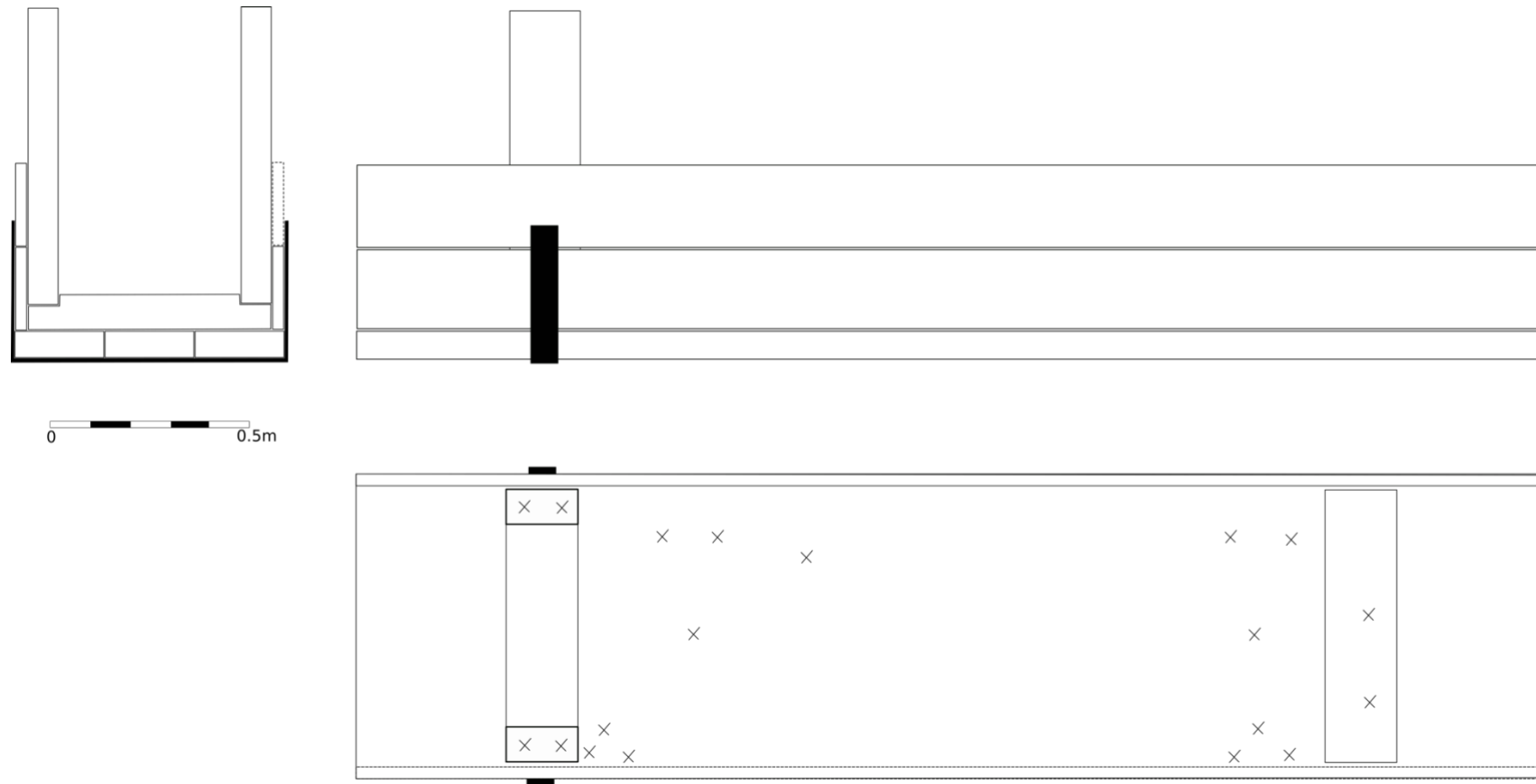


Figure 13. Measured drawing of the section of timber leat

## **8.2 Appendix II: Plates**

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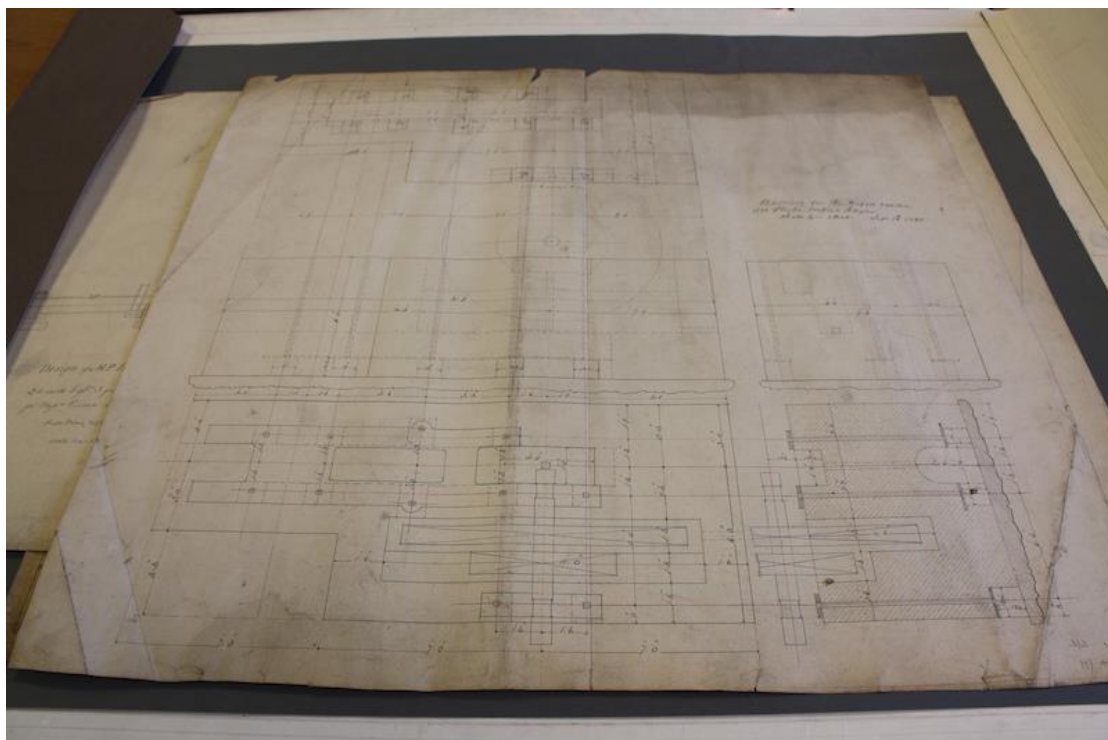


Plate 3. 'Masonry for the Hafod 24 inch diameter 3ft Stroke Vertical Engine Sep 26 1863'  
©West Glamorgan Archives (D/D NAI M/4634-113)

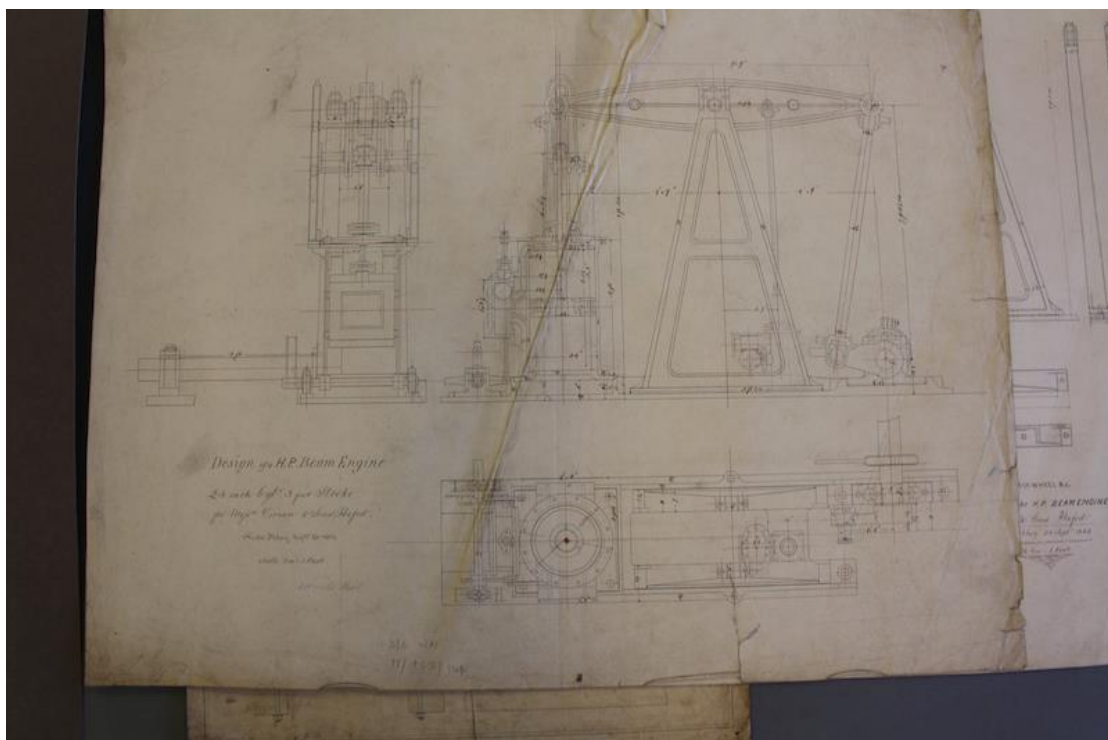


Plate 4. 'Design of 24 inch cylinder 3ft Stroke Vertical Engine Sep 26 1863'  
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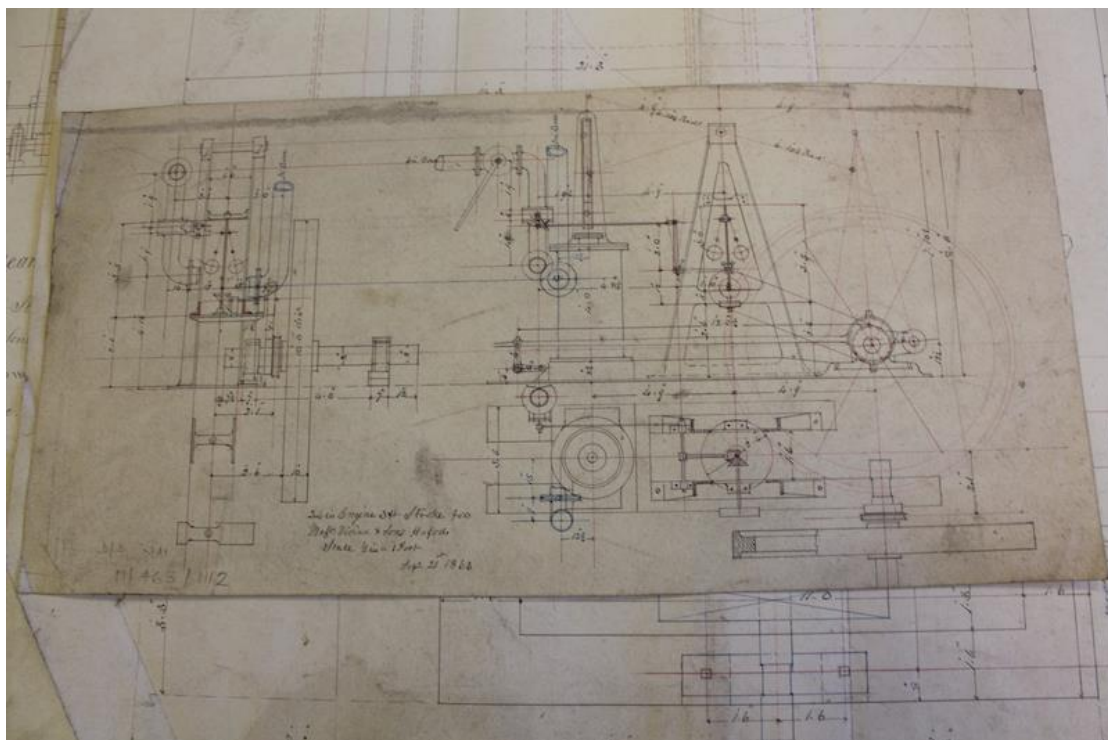


Plate 5. '24 inch 3ft Stroke Vertical Engine Sep 26 1863'  
©West Glamorgan Archives (D/D NAI M/4634-113)

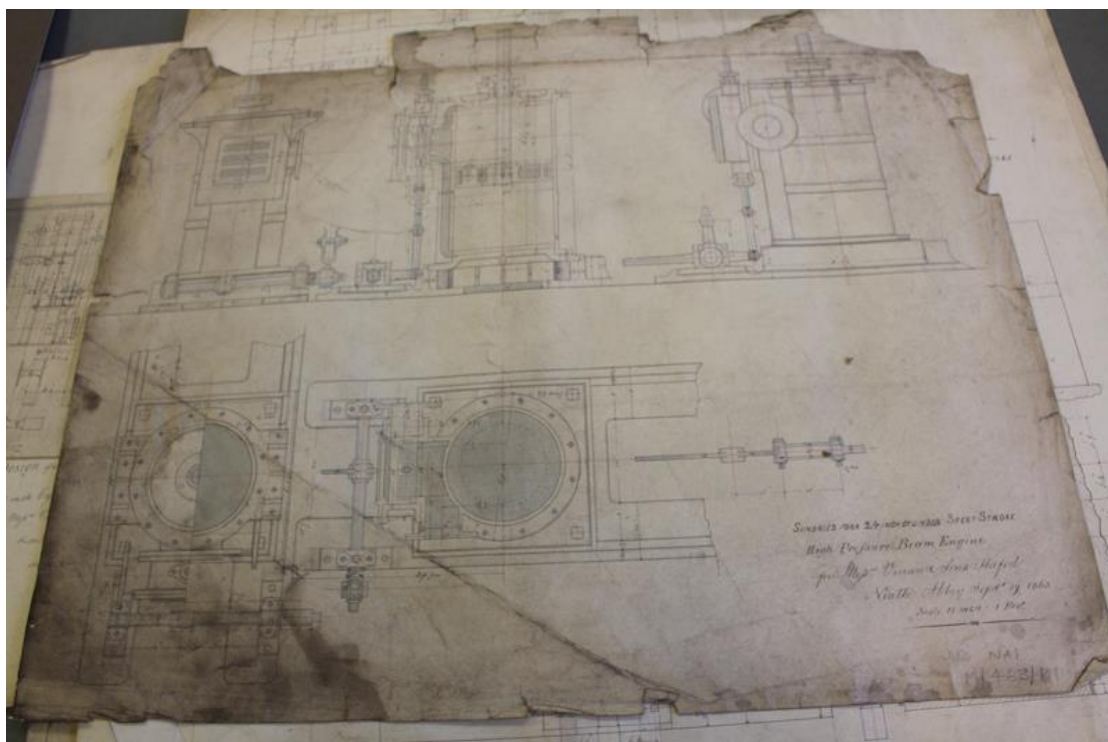


Plate 6. 'Sundries for a 24 inch cylinder 3ft Stroke Vertical Engine Sep 26 1863'  
©West Glamorgan Archives (D/D NAI M/4634-113)



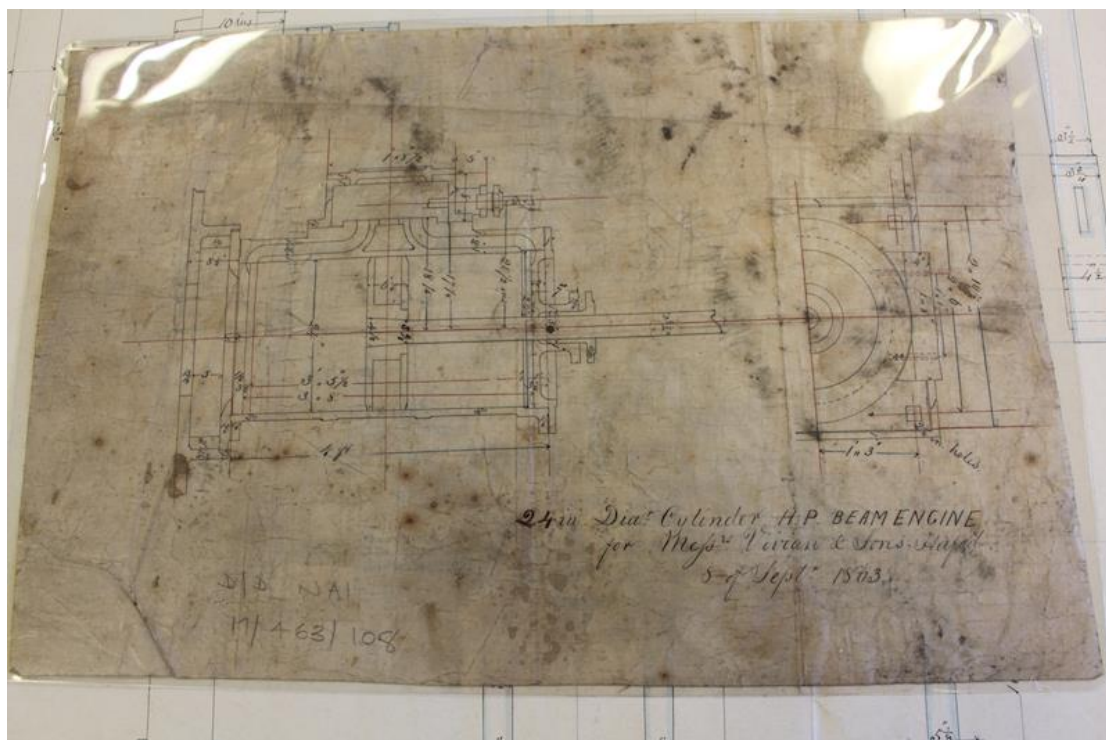


Plate 7. '24 inch 3ft Stroke Vertical Engine Sep 26 1863'  
©West Glamorgan Archives (D/D NAI M/4634-113)



Plate 8. 'Design for a pair of 23 inch 3ft stroke for a yellow metal rolling mill Dec 18 1858'  
©West Glamorgan Archives (D/D NAI M/21)



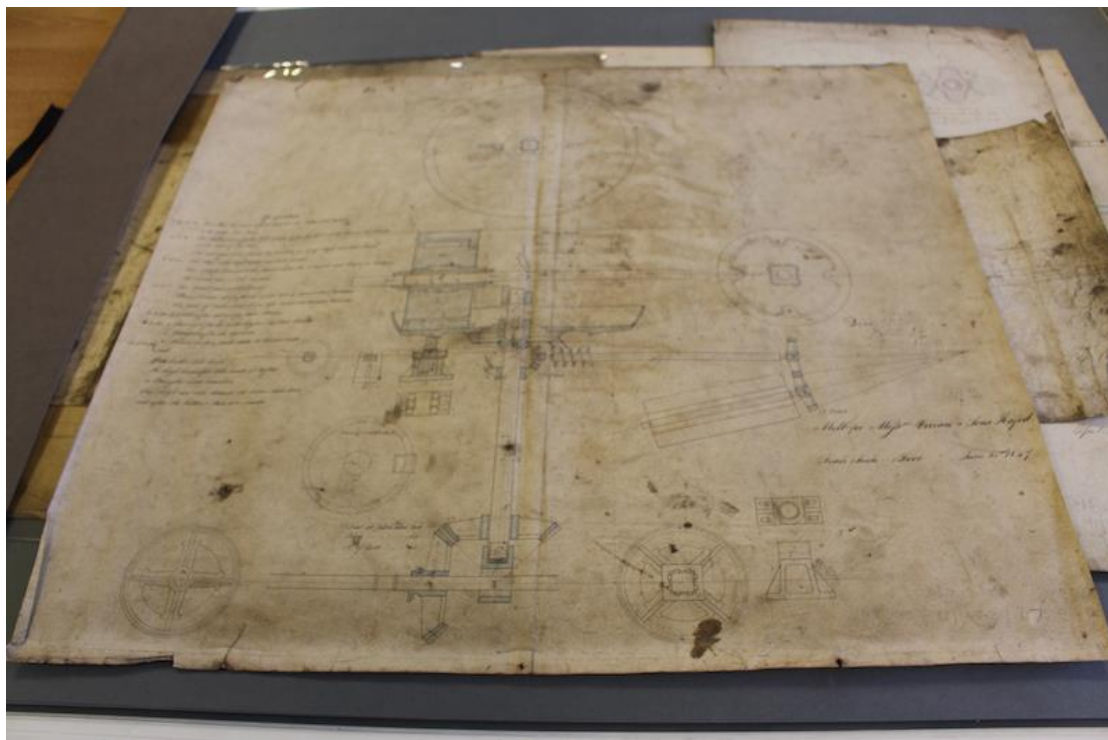


Plate 9. Drawings for a 40" engine dated to 1847 that possibly precedes the Vivian Engine House.  
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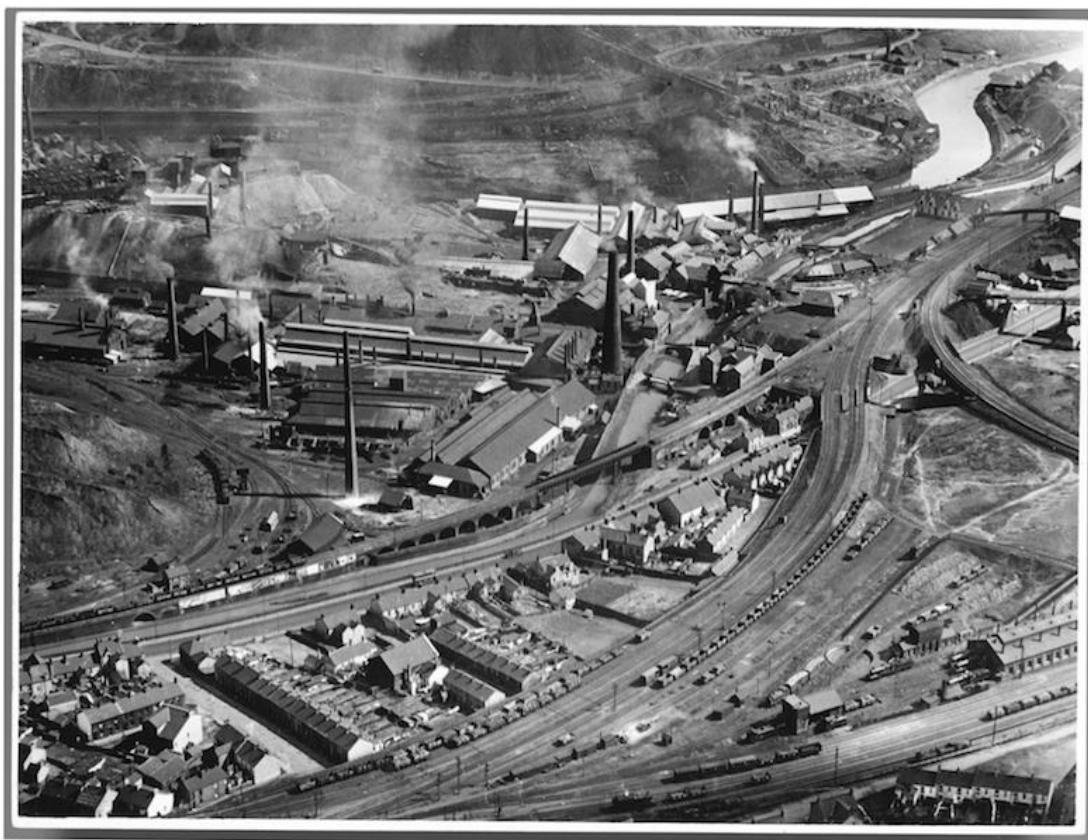


Plate 10. Late 1920s aerial photo showing the expanded Vivian Engine House surrounded by its rolling mill sheds. ©National Museum Wales (75.641/10-20)



Plate 11. West facing post-excavation photo of main basement [105] showing sump [103] in foreground.





Plate 12. South facing post excavation photo of basement [105] showing sump [103].





Plate 13. Working shot during the excavation of sump [103] showing water ingress.



Plate 14. Working shot during the excavation of sump [103] showing the back wall and in situ pipe work. It also shows brick backfill (102).





Plate 15. West facing post-excitation photo of sump [103] which was excavated to a depth of 1.6m but not bottomed. Also shows water ingress.



Plate 16. South facing post-excitation photo showing sump [103] to right and culvert [104] running beneath the east doorway. Also shows water ingress.



Plate 17. East-facing post-excavation photo of culvert [104], which is partially blocked with timber and laid with a land drain.





Plate 18. West facing pre-excitation photo showing deposit (201) within wheel pit [206] and inspection platform area [207] situated to the rear.





Plate 19. West facing photo showing re-deposited concrete slabs (202) within wheel pit [206].



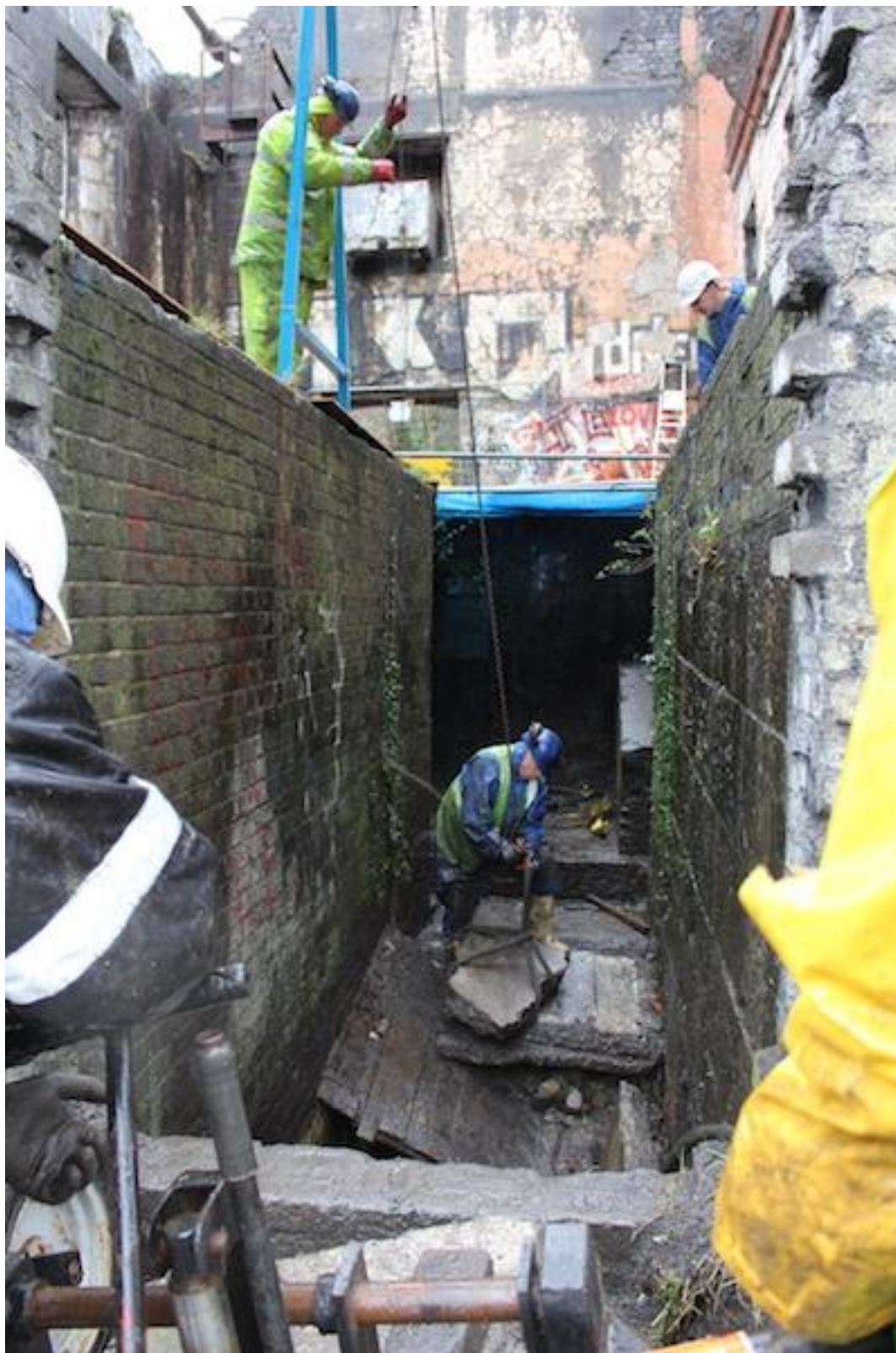


Plate 20. West facing working shot showing removal of concrete slabs using gantry hoist. Spanner board can be seen beneath slabs.



Plate 21. Working shot showing moment of discovery of the spanner board which lay face down beneath concrete slabs (202).





Plate 22. West-facing photo showing timber section of leat within wheel pit [206], prior to removal.



Plate 23. Working shot showing the removal of the timber leaf from wheel pit [206] using a gantry hoist.





Plate 24. Working shot during excavation of wheel pit [206] showing oil contamination of lower deposit (203).





Plate 25. Detail shot showing contamination of lower deposit (203).



Plate 26. Working shot showing rope chamber [205] and brick backfill (204) before excavation.





Plate 27. East-facing post –excavation photo showing rope chamber [205] extending east from the base of wheel pit [206]. Brick backfill (204) was not fully removed due to concerns about subsidence.



Plate 28. East-facing photo showing pennant stone north wall of rope chamber [205].



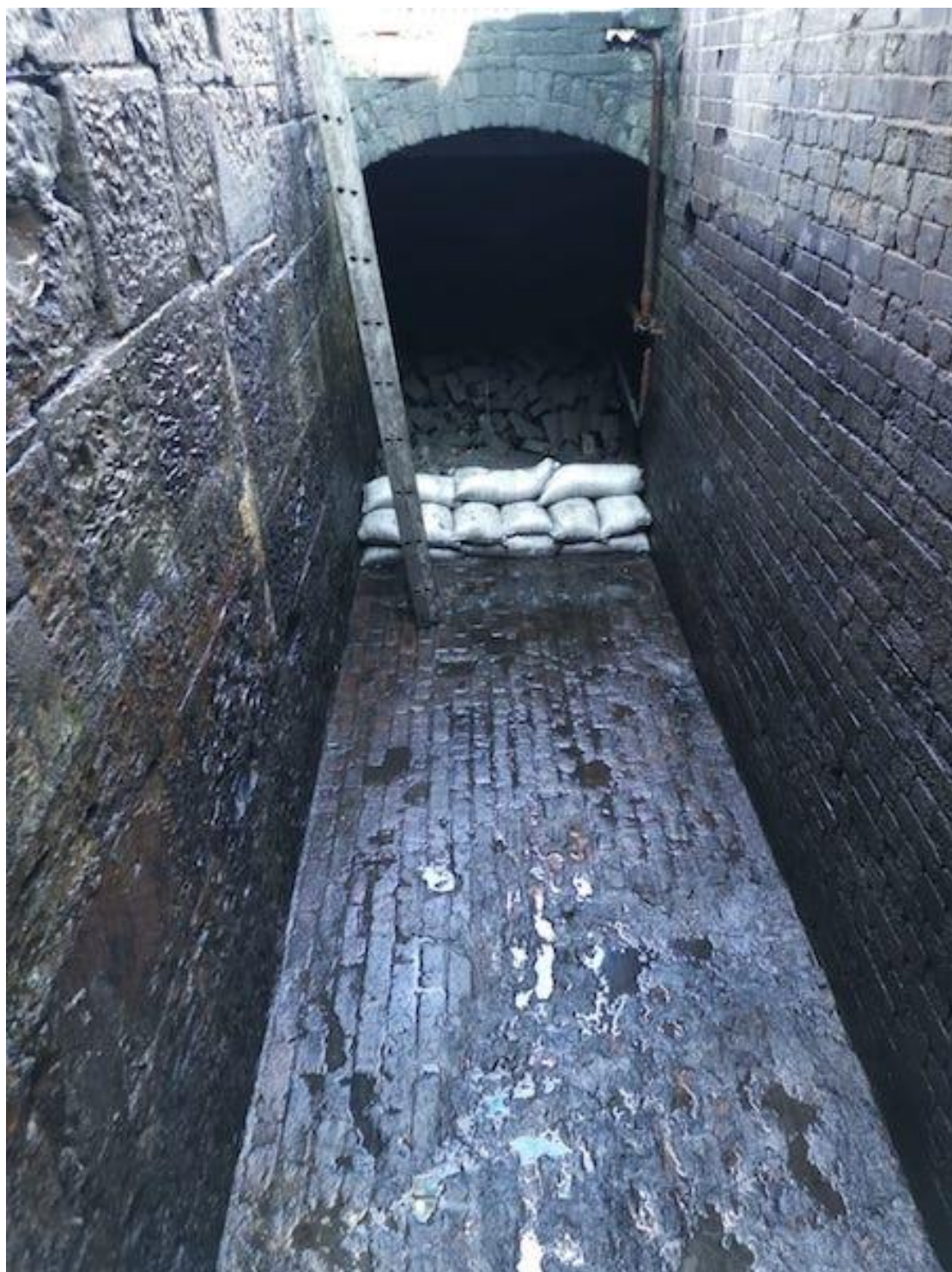


Plate 29. East-facing working shot showing the brick-lined floor of wheel pit [206].



Plate 30. West-facing photo showing pennant stone north wall of wheel pit [206]. The wall is extended up to machine floor level with Vivian ash brick.





Plate 31. West-facing photo of machine pit showing wheel pit [206] and inspection platform [207] to rear. Also shows steps to the base of the wheel pit.



Plate 32. East-facing photo from inspection platform [207] showing wheel pit [206] and rope chamber [205].





Plate 33. North-facing photo from inspection platform [207] showing access to manhole tunnel.





Plate 34. South-facing photo showing two of three brick arched recesses in south wall of inspection platform [207].



Plate 35. South-facing photo showing two of three brick arched recesses in south wall of inspection platform [207]. Also showing chute from machine floor.





Plate 36. West-facing photo showing west wall of inspection platform [207].



Plate 37. West-facing photo from east doorway showing the south wall of main basement [105]. The pennant stone lintel of sump [103] is visible in the foreground.





Plate 38. East-facing photo showing main basement [105] showing the south rubble stone wall and ash brick north wall with later red/ yellow brick infill.



Plate 39. West-facing photo showing the pennant stone west wall of main basement [105] and ash brick north wall with later red/yellow brick infill.





Plate 40. Detail photo showing a steel-lined sump located at the west end of main basement [105].



Plate 41. One of a number of blocked inspection hole/ vents. This one is located in stairwell [106].





Plate 42. West-facing photo of stairwell [106] showing brick arched recess at base of stairwell and later inserted slots to carry stairs. Later red/ yellow brick infill in the north and south walls of the stairwell is also visible.





Plate 43. North-facing photo showing recessed north wall of stairwell [106].



Plate 44. East-facing photo from main basement [105] showing east doorway and the pennant stone threshold stone that acts as the lintel for culvert [104].





Plate 45. Remains of stair string of staircase recovered from stairwell [106].



Plate 46. Detail photo of angled end of stair string recovered from stairwell [106].





Plate 47. One of a number of white-painted timber tongue & groove timber boards that were recovered from both main basement [105] and wheel pit [206].



Plate 48. White-painted timber tongue & groove boards recovered from both main basement [105] and wheel pit [206].





Plate 49. Examples of sections of timber ocular window frames recovered from both main basement [105] and wheel pit [206].



Plate 50. Examples of sections of timber window frames recovered from both main basement [105] and wheel pit [206].





Plate 51. Detail photo of window catch attached to section of ocular window frame. A further example remains in situ in the Vivian building.



Plate 52. Detail photo showing a brass window catch attached to section of ocular window frame.



Plate 53. North-facing photo showing in-situ ocular window frame.





Plate 54. Sections of timber window frame recovered from main basement [105].



Plate 55. Vivian patent ash brick.





Plate 56. Example of bricks recovered from sump [103], culvert [104] and rope chamber [205].



Plate 57. Example of bricks recovered from sump [103], culvert [104] and rope chamber [205].





Plate 58. Example of bricks recovered from sump [103], culvert [104] and rope chamber [205].



Plate 59. Example of bricks recovered from sump [103], culvert [104] and rope chamber [205].





Plate 60. Example of bricks recovered from sump [103], culvert [104] and rope chamber [205].



Plate 61. Example of bricks recovered from sump [103], culvert [104] and rope chamber [205].



Plate 62. Example of bricks recovered from sump [103], culvert [104] and rope chamber [205].



Plate 63. Example of bricks recovered from sump [103], culvert [104] and rope chamber [205].





Plate 64. Example of bricks recovered from sump [103], culvert [104] and rope chamber [205].



Plate 65. Example of bricks recovered from sump [103], culvert [104] and rope chamber [205].





Plate 66. Example of bricks recovered from sump [103], culvert [104] and rope chamber [205].



Plate 67. Example of bricks recovered from sump [103], culvert [104] and rope chamber [205].





Plate 68. Slate fragments. No full slates were recovered.



Plate 69. Quarry tile. These remain in situ in the machine floor of the Vivian Engine House.





Plate 70. Timber spanner board recovered from wheel pit [206].

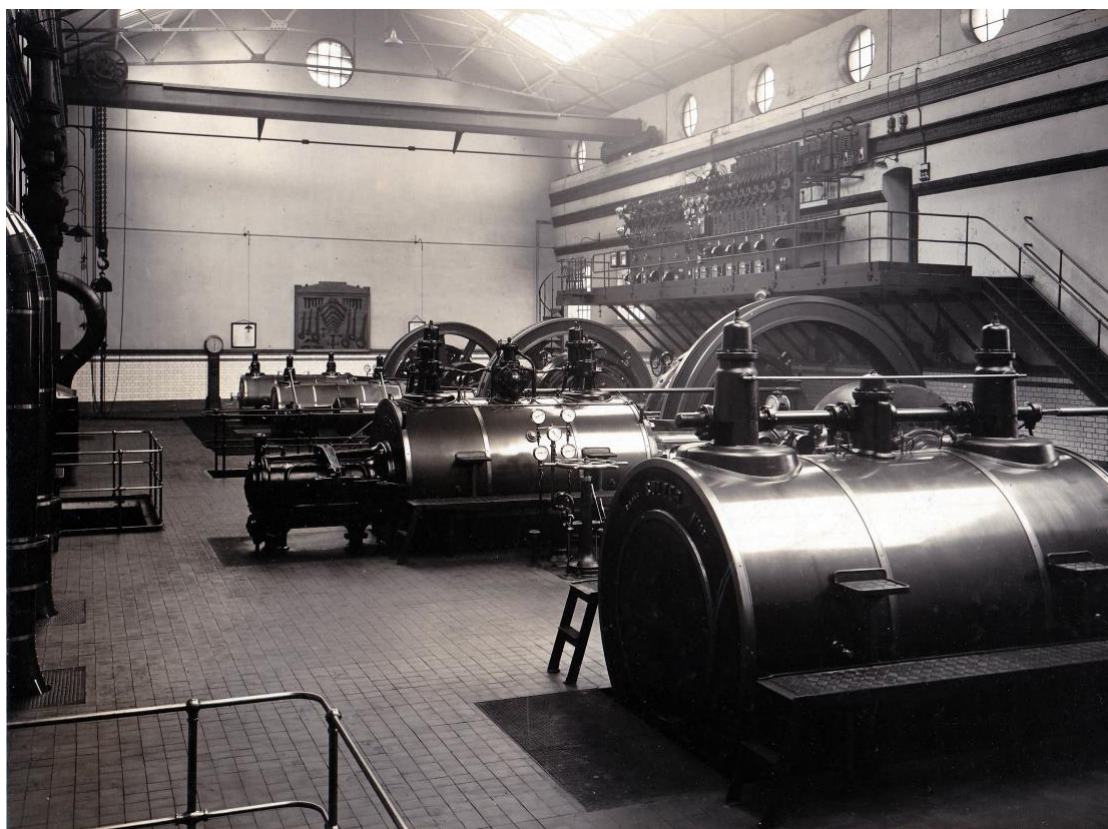


Plate 71. Historic photograph of an unidentified engine house showing a similar spanner board on the back wall.





Plate 72. Large section of timber leaf recovered from wheel pit [206].



Plate 73. Another view of the large section of timber leaf recovered from wheel pit [206].





Plate 74. End view of the large section of timber leat recovered from wheel pit [206].



Plate 75. Hammered copper bowl recovered from the base of wheel pit [206].



Plate 76. Copper metalworking hammerhead recovered from the base of wheel pit [206].





Plate 77. Brass weights recovered from the base of wheel pit [206].



Plate 78. Very large cast counterweight recovered from wheel pit [206].





Plate 79. Very large counter weight recovered from wheel pit [206].



Plate 80. Fire box ash scraper recovered from inspection chamber [207].





Plate 81. Metalworking tool recovered from wheel pit [206].



Plate 82. Metalworking tongs recovered from wheel pit [206].





Plate 83. Spanner recovered from wheel pit [206].



Plate 84. Adjustable spanner/ calliper recovered from wheel pit [206].





Plate 85. Strips of copper and brass recovered from wheel pit [206].



Plate 86. Clog-soled work boots recovered from wheel pit [206].



Plate 87. Coronet milk bottle recovered from base of wheel pit [206].





Plate 88. Large section of cast engine casing recovered from wheel pit [206].





Plate 89. Electric drive recovered from wheel pit [206]



Plate 90. Examples of asbestos gasket recovered from wheel pit [206].





Plate 91. Examples of sections of pipe recovered from wheel pit [206].





Plate 92. Example of section of pipe recovered from wheel pit [206].



Plate 93. Example of sections of pipe recovered from wheel pit [206].





Plate 94. Pipe valve recovered from wheel pit [206].



Plate 95. Pipe valve recovered from wheel pit [206].





Plate 96. General shot of nuts, bolts and metal plates recovered during excavation.



Plate 97. General shot of substantial number of whole bricks recovered from main basement [105].





Plate 98. General shot of items recovered from lower deposit (203) of wheel pit [206].



Plate 99. General shot of items retained from watching brief.

### **8.3 Appendix III: Context Inventory**

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**Table 2. Context Inventory**

Context	Type	Depth	Description	Period
101	Deposit	0m – 0.3m	Building demolition rubble well mixed with modern plastic and glass rubbish including packaging, bottles and stripped electricity cables (101) within basement [105] and stairwell [106]. Made up of a matrix of grey-black ash brick rubble and brick dust and humic material resulting from rotten timber and natural organic matter. Inclusions predominantly grey-black ash brick fragments of all sizes including a large number of whole bricks; cement mortar and cement render fragments.	Modern
102	Deposit	0.3m-1.65m (Not Fully Excavated)	Demolition material containing modern rubbish within brick-lined sump [103] and culvert [104]. The backfill was predominantly made up of a large number of whole bricks including Vivian ash bricks and a wide variety of other stamped types including yellow Nettle and red Adamantine examples.	Modern
103	Structure	n/a	Brick-lined sump measuring 1.28 x 1.16m within east end of basement immediately beneath threshold. Extends south beneath south wall and opens east into E/W aligned culvert [104].	Modern
104	Structure	n/a	E/W aligned culvert measuring 0.77m wide extending east from brick-lined sump 103. Pennant stone lined. Partially blocked at 1.55m and laid with a land drain seen to run for some distance.	Modern
105	Structure	n/a	Main basement. Measuring 1.3m wide x 9.8m long with a ceiling height of 2.6m. Pennant stone and rubble stone wall to west and south, ash brick walls to north and west. Poured cement floor. Joist filler concrete roof with access hatches to machine floor. Access doors to east and south. Large hole in south west corner to carry ?flue pipe. Steel lined sump at west end. Brick lined sump [103] and culvert [104] at east end. Machine base also in ash brick. Bricked up sections in red/ yellow brick show phases of modification and repair. Access to stairwell [106].	Modern
106	Structure	n/a	Stairwell. Measuring 2.5m wide x 4.25m long. Ash brick walls. Open to machine floor. Poured concrete floor but maybe brick-lined beneath. Brick arched recess at floor level. Wall above modified to take staircase. Holes in brickwork on north wall to take stair case wall tie brackets. Access to main basement [105]	Modern
201	Deposit	0m-0.75m	Building demolition material mixed with modern rubbish overlying inspection platform [207] and wheel pit [206]. This demolition material was predominantly made up of grey-black ash brick rubble, ranging in size from grit to whole bricks, and humic material originating from rotten timber and intrusive organic matter. Within this material there was a large amount of fragments of cement mortar and cement render, quarry tiles ranging from small fragments to whole tiles, small fragments of slate, medium to large pieces of concrete slab.	Modern



Context	Type	Depth	Description	Period
202	Deposit	0.75-1.15m	A series of large sections of concrete slabs (202) within wheel pit [206] of filler joist construction.	Modern
203	Deposit	1.15-2.65m	Continuation of demolition rubble backfill within wheel pit [206] consisting of grey-black ash brick fragments ranging in size from grit to whole bricks with frequent cement mortar fragments, occasional slate and occasional quarry tile fragments. Bottomed onto the brick-lined base of the wheel pit. A spillage of oil badly contaminated the remaining debris and it was not possible to identify any further detail as to its make-up.	Modern
204	Deposit	c.1.85m	Backfill of brick rubble within rope chamber [205] including many whole examples, of a mixture ash brick and industrial bricks including red Adamantine and yellow Nettle examples. Direction of backfill was not from the archway to the wheel pit as expected but instead from beyond the eastern edge of the concrete slab where a further void or culvert was visible. The feature was not fully excavated due to concerns about potential subsidence of the concrete slab roof and the surrounding external ground surface.	Modern
205	Structure	n/a	Rope Chamber. 2.63m long x 1.59m wide with a brick archway from wheel pit [206] measuring 1.8m high. Lined with pennant stone on both sides with internal ash brick buttress. Concrete slab roof that provides yard surface above. Further void visible at east end pointing to further structure beyond current work area.	Modern
206	Structure	n/a	Wheel pit. c.6m long x 1.9m wide x 1.88m deep from inspection platform on west side accessed by 5 steep steps. Pennant stone north wall and ash brick south wall. Brick-lined floor opening to rope chamber [205]. Open to machine floor above. Access hole in east external wall.	Modern
207	Structure	n/a	Inspection Platform. 3.3m long x 2.20m wide. Walls of ash brick with cement mortar. Pennant stone floor. Open to machine floor above. Features three arched recesses, a laddered manhole and a chute from machine floor. East end steps down to wheel pit [206].	Modern

## **8.4 Appendix IV: Cambria Archaeology (DAT) RCAHMW Survey**

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**Vivian Engine House, or No.2 Rolling Mill Engine House (BUILDING 8.0 - NPRN 33743)**

The engine house appears to be on the site of the 60hp engine of 1842 but there is no evidence that anything from this date remains. The present building is dated 1860-2 but has clearly been enlarged since then. It consists of a rectangular building with a chamfered west corner and contains a full height machine hall and a basement beneath; the machine floor is approximately 2.0m above ground level. All machinery has been removed. The tall red-brick chimney situated on the bank to the west of the building is said to be connected to this engine house. This was probably the site of the boiler complex that generated steam for both engine houses and other appliances.

*Exterior*

The building is constructed in Pennant sandstone and grey-black brick: snecked sandstone on three elevations, brick on the northeast elevation. The masonry walls are extended in height with grey-black brick. This and the brickwork on the northeast elevation are probably in Vivian & Sons own patent slag bricks. The masonry on the southwest elevation has blocks of relatively consistent size; that on the northwest and the eastern half of the southeast sides is a mixture of large, peck-dressed blocks and smaller roughly dressed blocks. The larger blocks may well be reused from the 1860 building or earlier. The south, north and east corners have dressed stone quoins; those at the north and east are larger and are pick-dressed. There are also quoins on the southwest wall where it meets the facet at the west corner. The northwest and southeast walls are extended above the masonry in grey-black brick. This is topped with a pediment of three courses of red header bricks, which also continues across the southwest elevation. The bottom course of the pediment is dentilled, the upper two projecting forward. Much of the northeast and southeast sides show traces of whitewash where the walls were inside adjoining buildings.

Southwest elevation: The left-hand (west) corner of the building is faceted; the facet wall is rendered, the remainder is masonry as described above. It is clear that the masonry wall indicates the original width of the building, as all openings below eaves level in this elevation are central to it. A central doorway giving access to the machine floor is accessed via external concrete steps. The opening has a camber-headed arch with stone voissoirs. There is a small rectangular opening containing a pipe, to the lower right of the doorway. Above the doorway, a stone plaque reads *Commenced August 1860, completed February 1862, V&S*. Above again is a central camber-headed window opening with a dressed-stone sill and stone voissoirs, the keystone projecting forward. The opening is blocked with red brick. A steel I-girder is set immediately above the sill. Above window opening, a frame made of I-girders projects forward from the elevation. To the right of window is a braced, cast-iron bracket and a similar one close to the west corner. The masonry wall is topped by a pediment in red brick. Above this the gable is in grey-black brick and spans the full width of the building. In its centre is a circular light bounded by a double row of header bricks. Remains of the wooden window frame are still in place. Truncated purlins show that the roof projected over the faceted corner and was rectangular in plan.

Northwest elevation: Of four-bays with tall, camber-headed windows lighting the machine hall. The openings have stone voissoirs with projecting keystones, and stone sills. The dressings appear to have a finer finish than those on the southwest elevation. Wooden window frames are in-situ. The windows had four large, rectangular panes, and above, an opening light of four small panes shaped to the camber. Above the masonry, the wall is extended in grey-black brick and above each window bay is a circular light with a surround of a double row of header bricks. Each light has a wooden window frame except the left-hand end one, which is blocked with brick.

On the stonework to the right of and above the second bay from the left, the pitch flashing of the sloping roof of a formerly adjoining building is visible. This does not continue on to brick portion.

Northeast elevation: This elevation is built entirely in grey-black brick apart from the corner quoins. There is a variation in the colour of the bricks at the highest level, probably due to differential weathering because of structures abutting the elevation below gable level. At the lower left-hand side is a square-headed doorway giving access to the basement. The opening has a steel rail lintel and a timber frame and door. Above the opening are the sawn-off stumps of a pair of U-channel girders set on edge in square holes blocked with brick. Towards the right-hand side there is a large opening giving access to the machine pit but extending high into the machine hall. The sill was probably originally at machine floor level, but the wall below has been knocked out to facilitate removal of machinery. Truncated timbers emerge from the wall either side of the opening. To the right is a narrow rectangular opening, a concrete lintel spanning both this and the larger opening. A similar rectangular opening with concrete lintel is close to the left-hand corner. Above, a lagged iron pipe emerges from the wall. The upper part of the elevation appears to have had a



frame attached to it. Three cast-iron inverted T brackets are set on chamfered stone corbels and above each, a mark on the wall show that a vertical member continued upwards as far as a square hole. In the gable is a circular opening similar to that on the southwest. The wooden window frame is more complete and contains an opening light, horizontally pivoted. A concrete slab to northeast of building is a former machine base.

Southeast elevation: The left-hand part of this elevation is considerable different to the right-hand; the difference in masonry style has already been noted. The right hand side has two camber-headed windows similar to those of northwest elevation; the right-hand one has its lower part blocked in red brick. Midway along the elevation, a square-headed doorway with a concrete lintel, gives access to basement. The stone sill is at ground level. In the left-hand part of the elevation are two windows, one above the other. Both are camber-headed with dressed stone sills and voissoirs with protruding keystones. The lower window opening is blocked in grey-black brick, the truncated ends of a pair of U-channel girders are set on edge in the blocking, and the sill has been hacked off. To the right of the window are the remains of a substantial steel bracket. Below the windows, concrete machine bases adjoin the wall and to the right of them, a hole in the wall was probably for a pipe. The quoins in the lower left-hand corner are chamfered and have a horizontal groove cut into them. Above, a cast-iron bracket is set in the wall and above that, a truncated I girder is set at an angle. High on this corner, are the traces of the concrete flashing of a pent roof against the wall and, to the right a cast-iron bracket similar to those on southwest elevation. Above the masonry, the wall is extended in brick in similar fashion to the northwest elevation. Of the four circular lights, the right-hand one is blocked.

### *Interior*

The machine hall is full height and open to the roof. The northwest part of the machine floor is taken up by a large pit, wider at its southwest end, where it was spanned by four I girders, now cut away. Three arched conduits lead southeast from the pit bottom. The pit is lined in brick except for the northwest side of the narrower section, where the lower part is constructed of masonry. An arched tunnel leads northeast from bottom of the narrow pit. A sloping bottomed recess extends southwest from the main pit, and alongside it to the northwest, are four holding down bolts for machinery. Northwest of the wider part of the pit is a square access shaft with iron bars set in it for footholds. At the bottom, it connects to the main pit through a low, arched opening. To the southeast of the pit is a concrete machine base and against the southeast wall, a metal-framed manhole. Alongside the narrow part of the pit, to the southeast, a wooden stair gives access to the basement. Walkway areas of machine floor have terra cotta quarry tiles. Interior walls are cement rendered with a high dado moulding around all four sides. The southwest part of the southeast wall is considerably wider than the rest and this and the southwest wall as far as the faceted west corner, are the remains of the 1860-62 build. The entrance in the southwest wall has a cast-iron sill and a cast-iron lintel behind the external stone voissoirs. The top of masonry walls on the northwest and southeast sides are corbelled out in red brick to provide ledges for the rails of a hoist, except on the 1860 part of the southeast wall, where this is not necessary. A galvanized water tank is set on a concrete slab in the blocked opening high in southwest wall. The remains of a vertical steel ladder lead to an iron landing at hoist rail level in south corner. A cast-iron pipe runs from south corner along southeast wall to east corner then down to machine floor. The roof is supported intermediately by three standard steel trusses and is timber-lined beneath the slates, although most of the roof covering is now missing.

### COMMENT

The former No.1 Rolling Mill Engine House is a good example of early 20<sup>th</sup> century upgrading of industrial plant, where the building and the machinery contained therein are designed as a single entity. This structure is particularly unusual because of the survival, not only of its engine, but also of a substantial part of the machinery for which it provided power. The engine is one the first Uniflow engines to be built and it is a particularly rare and important survival. I can find reference to only two other uniflow engines surviving in UK, neither of them by Musgrave & Sons.

In contrast, the former No.2 Rolling Mill Engine House shows how infrastructure was modified and expanded over time to cater for developing technology. There is no evidence of the 1842 building but the southwest wall and part of the southeast clearly belong to the 1860-1862 replacement. Later this engine house was rebuilt and extended to the northwest and probably to the northeast, presumably to accommodate a larger engine. It has been suggested that later still, the building was raised. This may be the case and the upper parts being built in brick would support this. If

this was the case then presumably the whole of the northeast wall was rebuilt at the same time. However, it is common in engine houses provided with railed hoists, for the walls above the rails to be considerably thinner than the lower part (e.g. the 1910 engine house). The brick sections of the northwest and southeast walls end at the same level as the masonry of the southwest (1860) wall, all three topped by the red-brick pediment. The southwest wall shows no indication of upper part being a different build to the lower. In addition, the dressed quoins on the north and east corners continue above the masonry. This would seem to be an unnecessary detail if the brickwork was later. It may be therefore that the brickwork is in fact contemporary with the initial enlargement of the 1860 engine house.

# CHIMNEY & ENGINE HOUSES

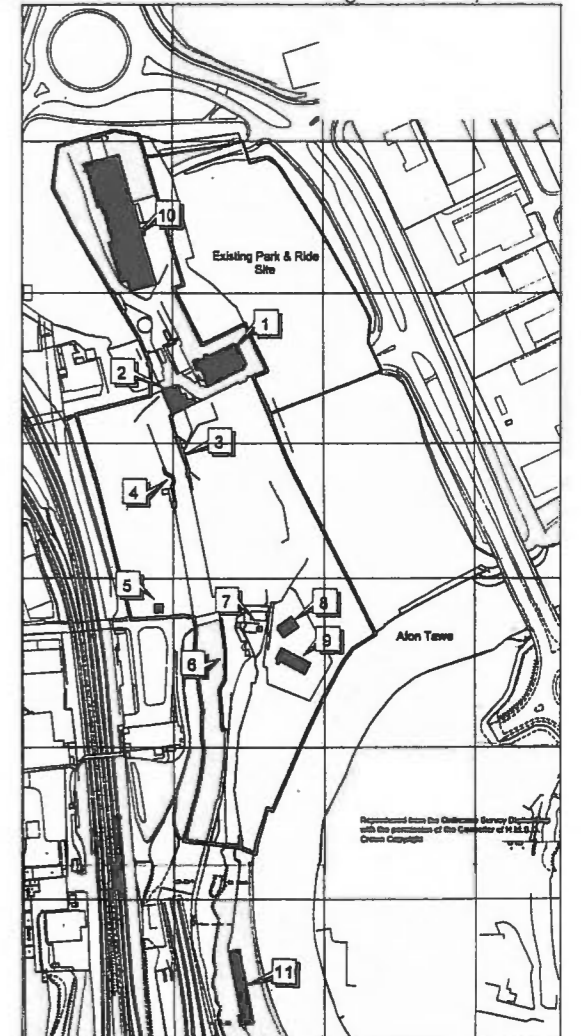
Yorkshire Imperial Metals  
Site, Swansea  
scale 1: 200



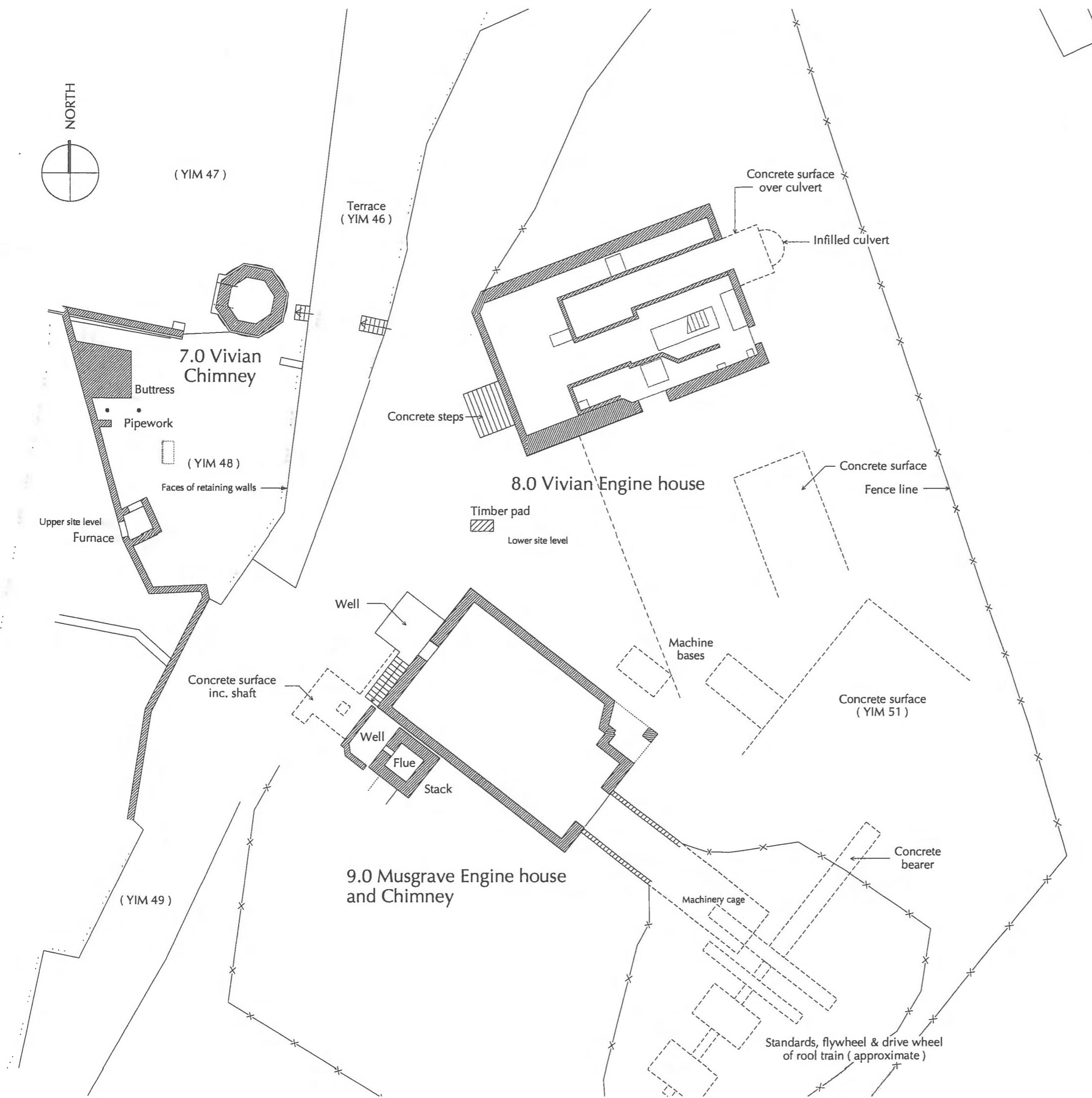
## EXISTING LOWER FLOOR

### Location Plan scale 1:5000

- Buildings & Structures -
- 1.0 Canteen building. Listed grade II, late C19. Former powerhouse of the Morfa Copperworks.
  - 2.0 Laboratory Building. Listed grade II, mid to late C19. Formerly part of the Morfa Copperworks.
  - 3.0 Pier and adjoining canal wall. Listed grade II, canal wall 1807 pier c. 1850.
  - 4.0 Copper slag abutment. Listed grade II, mid C19. The pier and abutment supported the waste tip tramroad over the Swansea canal.
  - 5.0 Hafod lime kiln. Listed grade II, mid C19
  - 6.0 Boundary wall of the canal docks of the former Hafod copperworks. Listed grade II, early C19
  - 7.0 Vivian chimney. Listed grade II, 1860 - 62
  - 8.0 Vivian engine house. Listed grade II, 1860 - 62
  - 9.0 Musgrave engine house. Listed grade II\*, built 1910 with latter additions.
  - 10.0 Musuem store. listed grade II, mid C19
  - 11.0 Vivian locomotive shed. Listed grade II, early C20



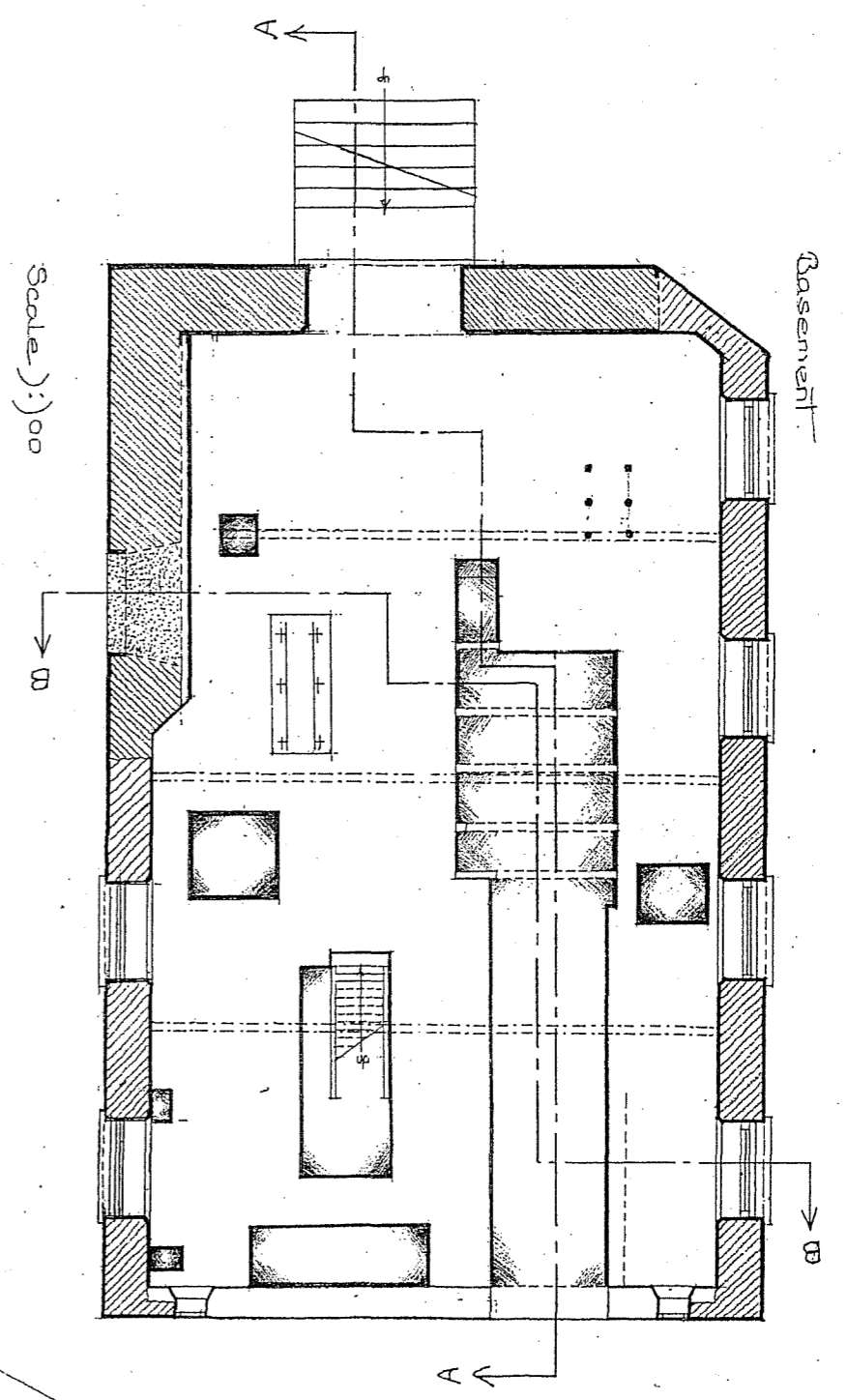
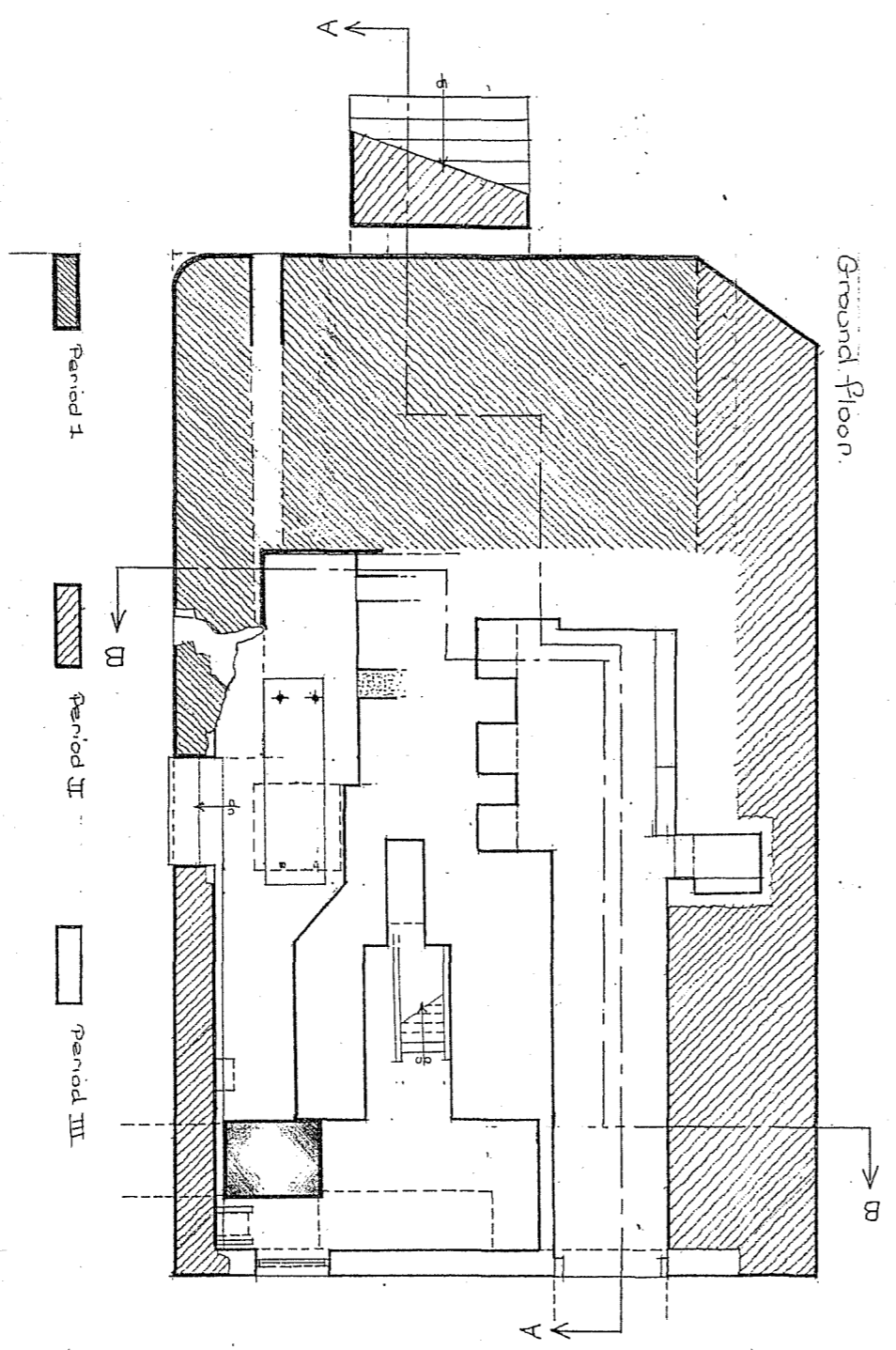
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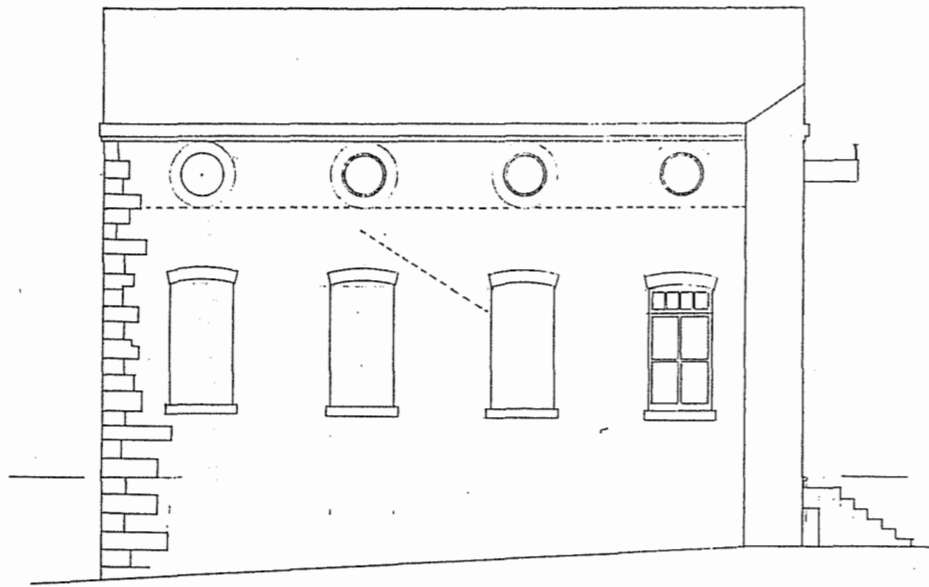
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Dr Roberts - March 2000

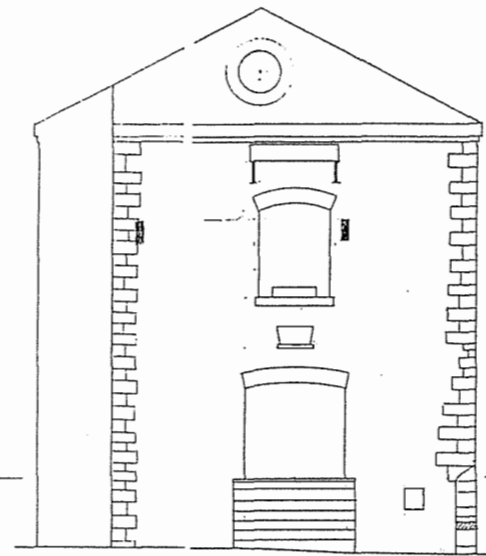


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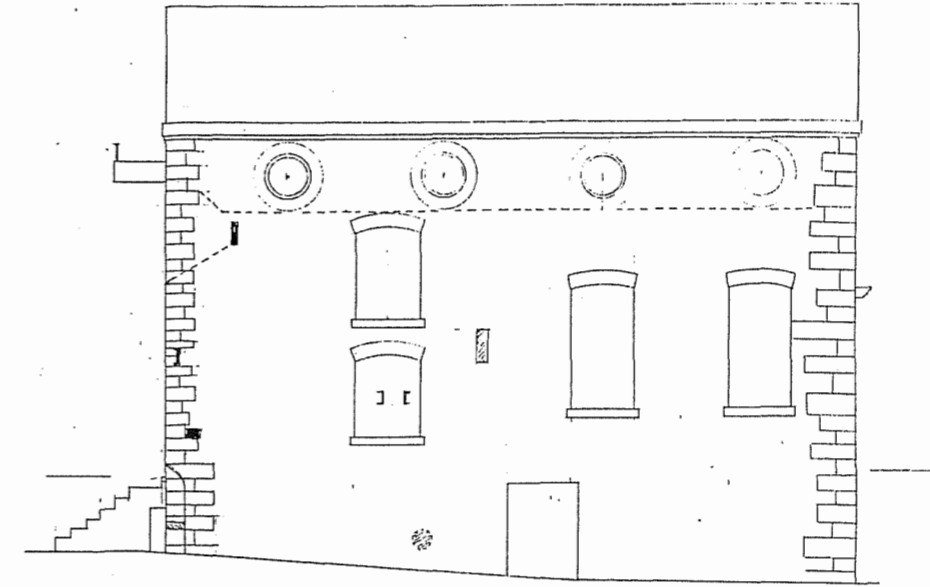
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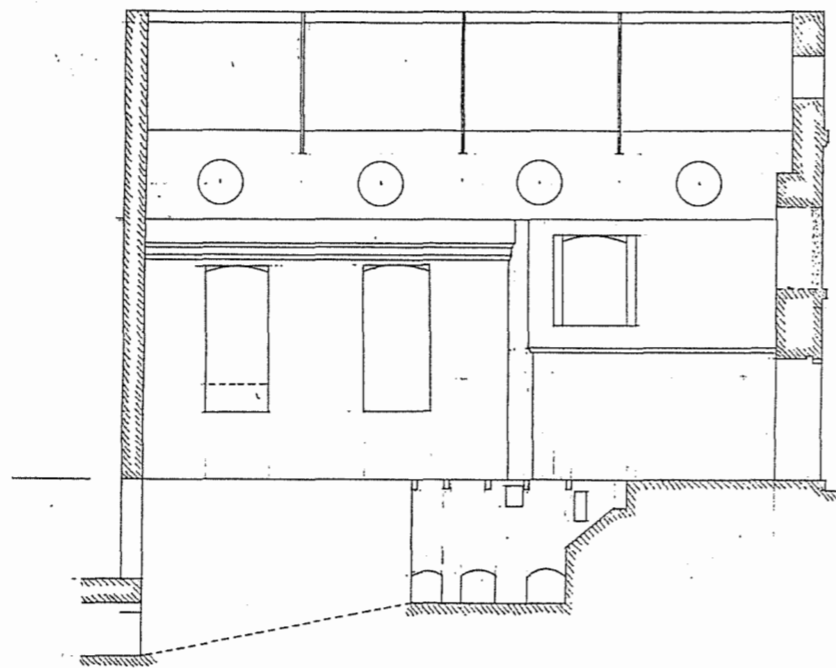
NORTH-WEST ELEVATION



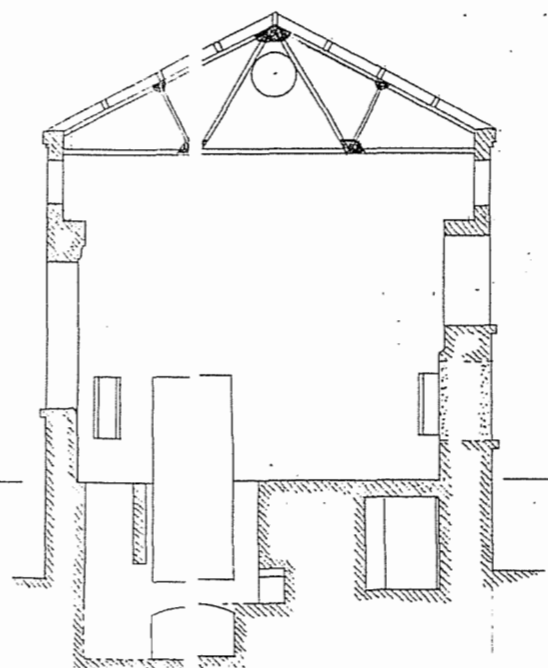
SOUTH-WEST ELEVATION



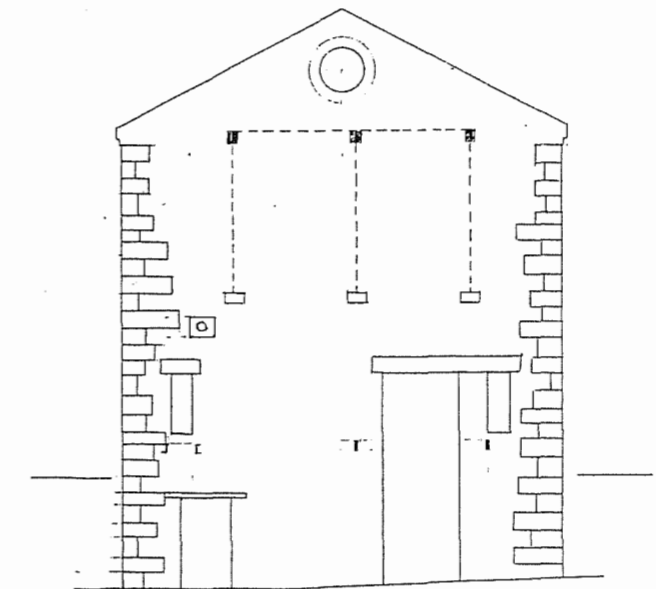
SOUTH-EAST ELEVATION



COMPOSITE SECTION A-A



COMPOSITE SECTION B-B



NORTH-EAST ELEVATION

0 10  
Metres

## **8.5 Appendix V: Mann Williams Site Visit Report 02**

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# Vivian Engine House

## Site Visit Report 02

23/08/2019

Project Number: 9682

Date: Aug 2019

Rev: P1

# Content/Quality Assurance

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TM	PR	PR	30/08/2019

## 1.0 Introduction

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- 1.1 The Vivian Engine House is believed originally to date from 1860. The building as it stands today is a much altered and extended version of that original engine house, probably dating largely from the early 20<sup>th</sup> century. It is listed Grade 2. It is semi-derelict, having been disused since the closure of the Morfa Copperworks in around 1980.
- 1.2 The engine house comprises a single space approximately 15m x 10m on plan. It is oriented with its long axis NE/SW. There is a 'lower ground floor' over parts of the building footprint, mostly located approximately at external ground floor level. The main floor level is at upper ground, approximately 2m above surrounding external ground level.
- 1.3 The engine house forms part of the wider complex of standing remains of the copperworks site and is located immediately adjacent to the Musgrave Engine House.
- 1.4 Phased conservation works are being undertaken to structures across the Copperworks site. As part of this programme, Swansea Council are currently consolidating the most vulnerable parts of the Vivian Engine House, to secure its fabric. These works are currently in progress on site, the building is scaffolded, and masonry works to the most vulnerable section of masonry at high level are progressing.
- 1.5 Mann Williams were asked to attend site to inspect an area of stonework exposed by dismantling of the vulnerable high-level masonry to the chamfered corner linking the north west and south west elevations. This stonework did not appear to match our expectations of this area of the building contradicting our understanding of the building development process as described in our previous report 9682\_R\_PR\_02\_02 "Structural Summary Notes to Support Application for Listed Building Consent".



## 2.0 Site Observations

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- 2.1 There have been a number of investigations and observations in this area which have informed the proposed interventions in this area as well as the appraisal process. These are summarised below:
- Patches of the render panel were removed to confirm the render is cement based and the brick behind is red brick the full height, this also confirmed the “quoins” on the side elevation are render over red brick. The change from rendered red brick to copper slag brick occurs at the internal crane rail level.
  - Local breaking out of the brick and the removal of the copper slag bricks demonstrates the quoins in the south west elevation are a previous corner.
  - Failed sections of the inside render suggest the chamfered corner is copper slag brick the full height.
  - The south west gable has a ground level opening, plaque, first floor level window and projecting steel beams which are all centred on the straight section of the rear elevation (ie between the two stone quoins) and a high-level circular window centred on the full building width.
  - The current dismantling has shown a stone wall with outside face set back but parallel to the outside face of the rear wall and an inside face flush with the rear wall. This was buried in the chamfered corner brickwork with the brickwork pieced in around the rough stone edges.
  - The two side walls have high level bands of copper slag bricks with circular windows. All corners of the building except the chamfered corner have consistent stone quoins up to the top of this band. The base of this band is at the level of the internal crane rail shelf which is formed from an internal red brick corbel and a change in thickness of the wall.
  - At the top of the band of copper slag bricks is a red brick corbel detail on the south west, north west and south east elevations. This is not present on the chamfered corner but is present on the newly found recessed stonework.
  - The spacing of the circular windows matches on both elevations and is even. The distance between the north east elevation and closet window does not match the distance between the closet window and the south west elevation, chamfered corner or newly found recessed stonework but is closest to the latter.
  - The south west gable and half of the south east side wall are around 900mm thick, the remainder of the walls are around 650mm thick.
- 2.2 These items are illustrated by the photographs below from a variety of phases of construction and the excerpts from the photogrammetric orthographic elevations.

2.3 Site Photographs



Aug 2019



Aug 2019



Feb 2019



Feb 2019



March 2019



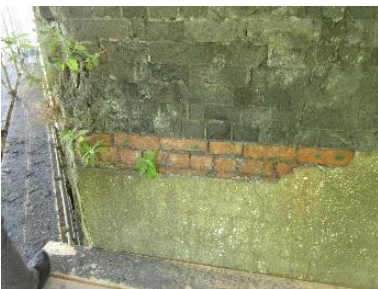
April 2019



July 2019



July 2019



July 2019



2.4 Photogrammetric Orthographic Elevations



South West external elevation



North West external elevation



Plan at window cill level



South West internal elevation



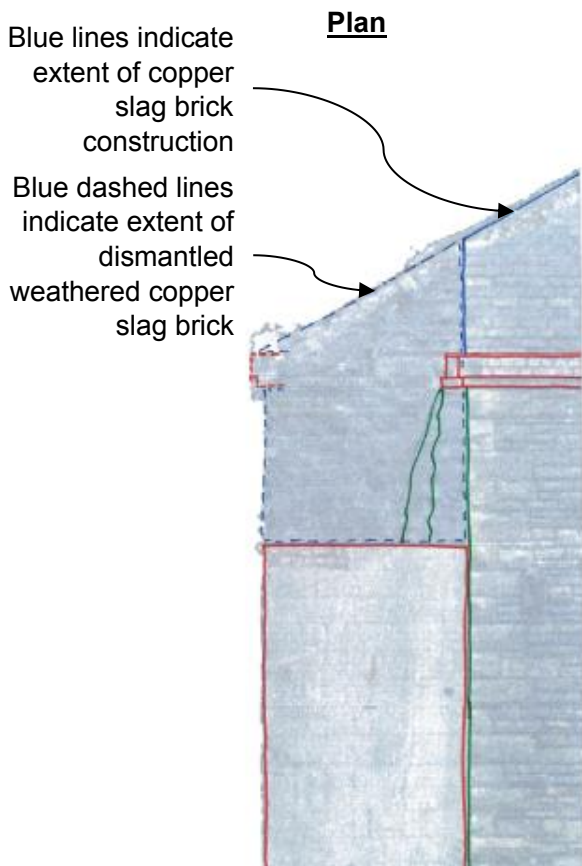
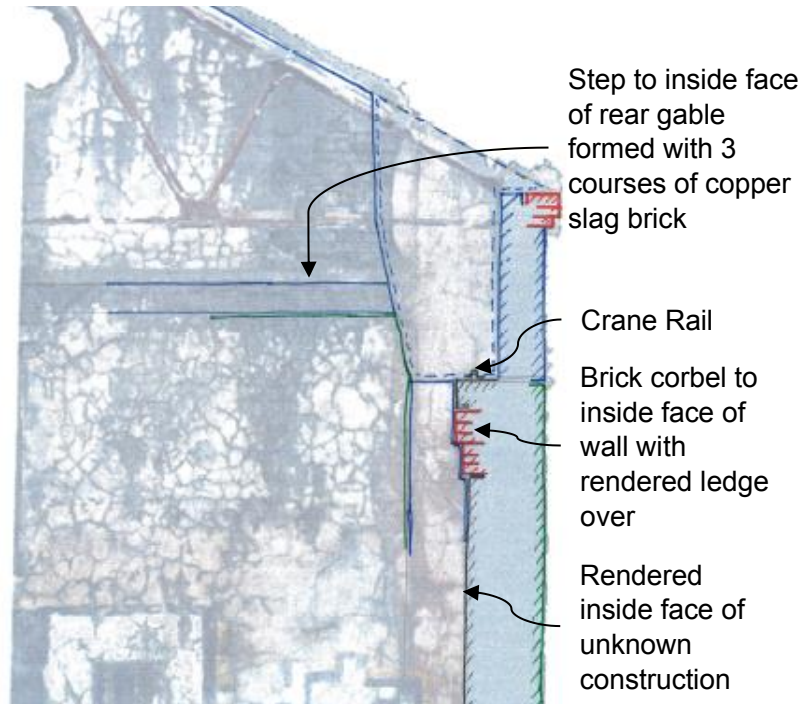
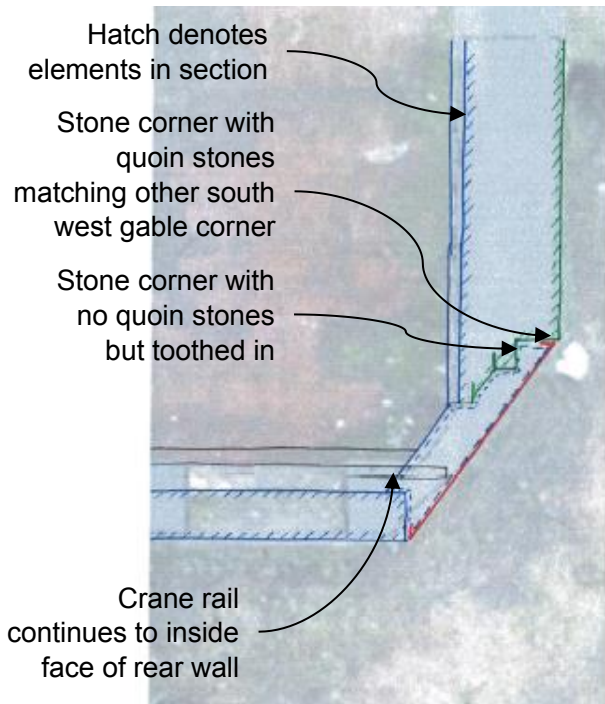
North West internal elevation



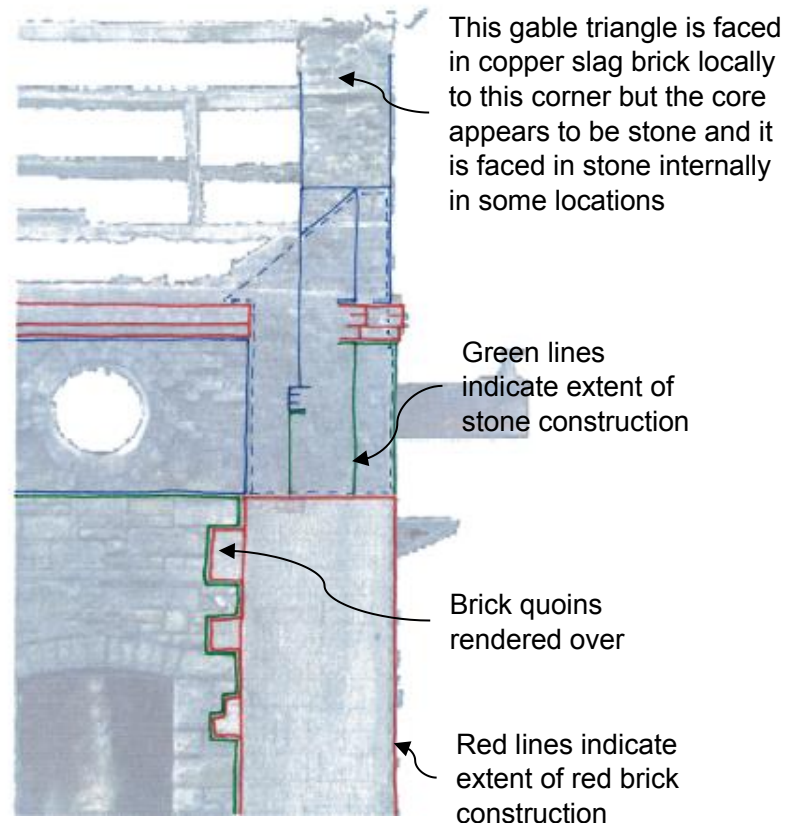
Plan at roof level



2.5 The following sketches record the current materials of this corner of the building



**South West Internal Elevation / Side Wall Section**



**South West External Elevation**

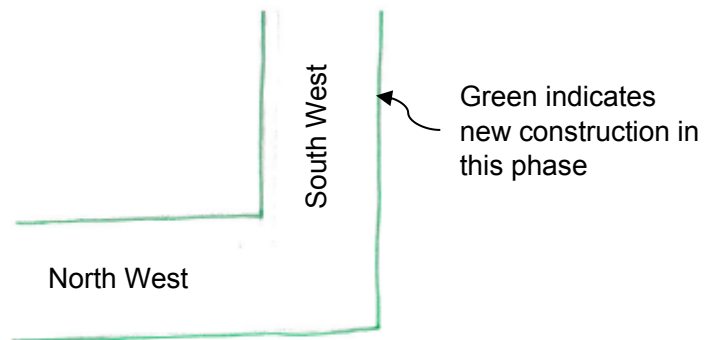
**North West External Elevation**

## 3.0 Discussion

- 3.1 The presence of this new wall, revealed by the dismantling of the chamfered corner, suggests an additional stage of the buildings development and adds understanding to this development. It demonstrates the chamfered corner was added and prior to this there was a dogleg in the rear gable. The relationship with the crane rail and brick corbel detail also give indications as to the sequence of alterations to the height of the building.
- 3.2 The current thinking regarding the alterations to the building is described below with sketches and supporting / contradictory evidence.

### 3.3 Initial Building Layout

3.3.1 The oldest portion of the building remaining is the south west elevation and half of the south east side wall. This suggest a roughly square original building with the north west side wall on the line of the existing quoins at the edge of the chamfered corner.



3.3.2 This is supported by the line of stone quoins, the variation in wall thickness, the symmetry of the south west elevation and the lack of consistency of openings in the south east side wall. This north west wall position appears to line through with the north west side of the "wheel pit".

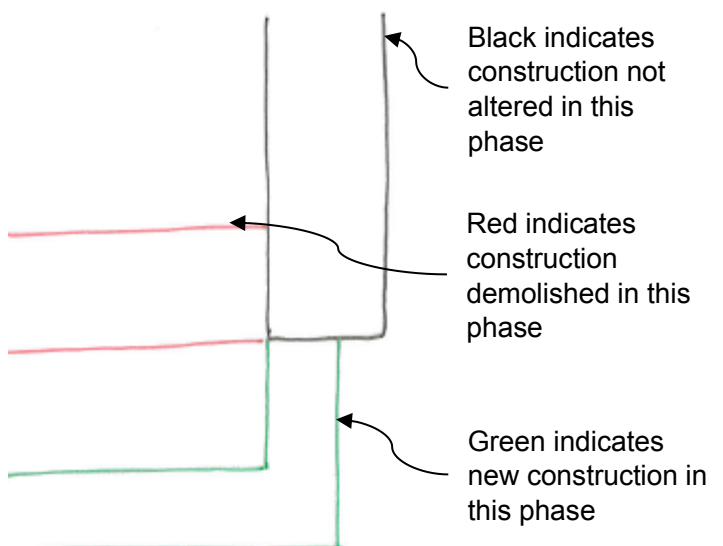
3.3.3 The only discrepancies with this are the lack of a scar or straight joint on the inside of the rear elevation and the tothing in of the doglegged section of rear elevation.

### 3.4 Building Extension on Plan

3.4.1 During this phase the building appears to have been extended on plan to the north and east to its current overall dimensions. The west corner had a dogleg of 350mm in its outer face and was straight on its inner face.

3.4.2 This is mainly evidenced by the portion of stone walling now uncovered and the crane rail which has been shown to extend to the inside face of the rear wall.

3.4.3 There is a discrepancy in wall thickness between the dogleg section at 550mm and the side wall at 650mm. There is also a question as to what was gained by this dogleg.



### 3.5 Changes in Building Height

3.5.1 As we currently see it there are three plausible sequences of construction for the changes in building height supported by the evidence on site.

3.5.2 **Constructed concurrently with building extension** – The wall profile as it is currently could have been constructed in one phase when the building was extended on plan.

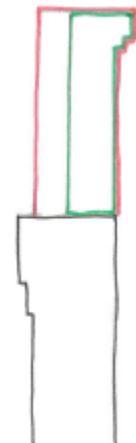
3.5.3 The consistent stonework of the south west elevation shows this, and therefore the original section of the south east side wall, were this height. The north east gable being in consistent copper slag brick the full height also suggests it was built in one phase

3.5.4 However, there is a distinct change in the stone quoins of the north east elevation suggesting they were not all built concurrently. The top triangle of the south west elevation is distinct from the remainder of this elevation which with the symmetry of the circular window suggest it was an addition.

3.5.5 **Built in stonework then thinned** – The wall may have been built to its current height in stonework with consistent thickness. The internal brick corbel may or may not have been present as a narrower crane rail. In order to add or extend the ledge for the crane rail the top section of this wall could have been dismantled and replaced with the thinner copper slag brick wall.

3.5.6 This would explain the use of stone quoins on the north east elevation for the high-level copper slag section.

3.5.7 The top section of the south west gable being faced in copper slag brick rather than stone contradicts this sequence. Also, this is quite wasteful of materials, the thinner wall is 400mm thick which could have been built in stone using the reclaimed material.





3.5.8 **Wall built to top of stone level and then extended** – The wall could have been built up to the current top of stone level when the building was extended on plan. At a later date to accommodate a crane this could have been extended upwards in copper slag brick to create a crane rail shelf and clearance to a new roof structure.

3.5.9 This is generally supported by the changes in material at this level on both side walls and the quoins of the north east elevation.

3.5.10 However, there is no corresponding change in construction of the north east and south west elevations at this level. Also, in the original portion of the south east side elevation there is a window with very little stonework over and a fillet of stonework running into the rear elevation quoins which suggest this stonework was once higher.

3.5.11 The red brick corbel band ties the two side elevations and the south west gable together and is suggestive of a single phase of construction. However, as there is no stonework above this detail it is not possible to date its construction. Therefore, all it really suggests is copper slag bricks in the side elevations and south west elevation were constructed in one phase.

3.5.12 On balance we think the most likely sequence is that the whole wall was constructed concurrently with the building's extension on plan. The change in construction of the north east elevation stone quoins may just reflect the quoins being robbed from the original building and them not having enough. The change in construction of the south west elevation does not preclude this from being added at the same time.

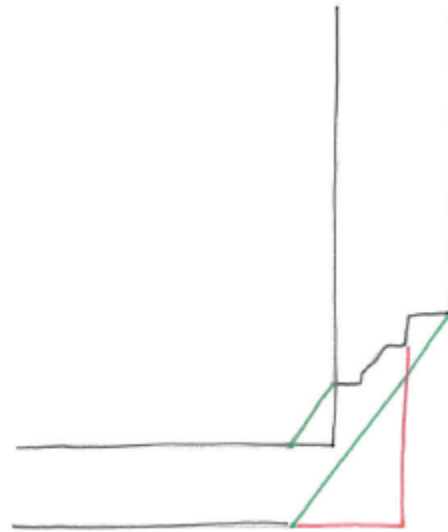


### 3.6 Corner Chamfer

3.6.1 The final alteration to the building layout appears to be the chamfering of the north west corner. It appears a portion of the side wall and most of the dogleg section of the rear wall was demolished the full height of the building. A new chamfered wall was constructed from red brick and rendered up to crane rail level. Above this and internally it was constructed in copper slag bricks.

3.6.2 The eaves level brick corbel detail continues onto the dogleg section of rear gable which with the crane rail length suggest the chamfer was a later alteration. There is also a slight change in appearance and weathering of the chamfered panel of copper slag brick in comparison to the side elevation, there is less variation in degradation and more projecting mortar joints.

3.6.3 The most significant discrepancy is the render to the red brick which is cement based in contrast to the masonry underneath being in lime mortar.



## 4.0 Conclusions

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- 4.1 In general, the primary impact of this discovery is to assist in understanding of the development of the building. It has very little impact on the currently proposed consolidation and repair works.
- 4.2 We have presented our observations and findings in this site visit report which should be circulated to Cadw and Swansea City Council Based on this they can determine if any further recording of the area is required.
- 4.3 In terms of the proposed works the intention was to replace the panel of copper slag bricks on the chamfer. We do not see any reason to change this providing the stone wall is maintained in situ and encapsulated. Framing ties should be provided into the stonework to tie it to the new construction.





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