THE CHARCOAL-FUELLED IRONWORKING INDUSTRIES OF CARMARTHENSHIRE AND PEMBROKESHIRE

VOLUME 1: THE SURVEY

Report No. 2002/26

Report Prepared for:
CADW: WELSH HISTORIC MONUMENTS

ARCHAEOLEG
CAMBRIA
ARCHAEOLOGY

CAMBRIA ARCHAEOLOGY

REPORT NO. 2002/26
PROJECT RECORD NO. 44754

CHARCOAL-FUELLED IRONWORKING INDUSTRIES OF CARMARTHESNHIRE AND PEMBROKESHIRE
VOLUME 1: THE SURVEY

March 2002

By

Nigel Page & Hubert Wilson

ARCHAEOLEG CAMBRIA
Ymddiriedolaeth Archaeolegol Dyfed Cyf
Neuadd y Sir, Stryd Caerfyrddin, Llandeilo, Sir Gaerfyrddin SA19 6AF
Ffon: Ymholiadau Cyffredinol 01558 823121
Adran Rheoli Treftadaeth 01558 823131
Ffacs: 01558 823133
Ebost: cambria@acadat.com Gwefan: www.acadat.com

CAMBRIA ARCHAEOLOGY
Dyfed Archaeological Trust Limited
The Shire Hall, Carmarthen Street, Llandeilo, Carmarthenshire SA19 6AF
Tel: General Enquiries 01558 823121
Heritage Management Section 01558 823131
Fax: 01558 823133
Email: cambria@acadat.com Website: www.acadat.com

The Trust is both a Limited Company (No. 1198990) and a Registered Charity (No. 504616)
CADEIRYDD *CHAIRMAN: B.C.BURNHAM, MA PHD FSA MIFA.* CYFARWYDDWR *DIRECTOR: E G HUGHES BA MIFA*

THE EARLY POST-MEDIEVAL CHARCOAL-FUELLED IRONWORKING INDUSTRIES OF CARMARTHENSHIRE AND PEMBROKESHIRE A SURVEY

CONTENTS **PAGE**

THE EARLY POST-MEDIEVAL CHARCOAL-FUELLED IRONWORKING INDUSTRIES OF CARMARTHENSHIRE AND PEMBROKESHIRE A SURVEY

SUMMARY

The use of charcoal-fuelled blast furnaces and forges had reached Carmarthenshire by the later 16th century and Pembrokeshire by the early 17th century. Unlike some other areas there was no great ironworking tradition in the area prior to the introduction of the blast furnaces, so the early works were established by ironmasters from outside the area attracted by the availability of raw materials and an abundance of woodland for timber and charcoal.

The physical remains of some of the most important sites associated with the early post-medieval ironworking industry are still visible in the landscape, although they are little known and generally in poor condition. Unusually, above ground remains survive for the earliest sites in both Carmarthenshire and Pembrokeshire. These sites, the furnaces at Ponthenri, Carmarthenshire, and Blackpool, Pembrokeshire, are the very beginning of an industry that in Carmarthenshire developed into one of the county's bedrock industries.

This project was initiated to record the surviving remains of the most important and best preserved of the sites and to provide up to date information on the condition of all sites identified as being associated with the charcoal-fuelled iron industry. First time topographic surveys were produced for the late 16th century furnace at Ponthenri and 17th and 18th century forges at Llandyfan, all in Carmarthenshire.

The project has shown that the physical remains of the ironworking sites are a small and fragile resource. The current condition of the sites is a major concern and without some form of active management their long-term survival is doubtful. Therefore, a series of recommendations has been made for a short-term programme of remedial works and longer-term management.

INTRODUCTION

The early post-medieval charcoal-fuelled ironworking industries of Carmarthenshire and Pembrokeshire have left significant, if somewhat scant, evidence, in the form of surviving archaeological sites and documentary records of how the industry developed and the influence it had on the landscape. Whilst never developing to the extent of other iron producing areas, the industry, in Carmarthenshire at least, developed into one of the area's bedrock industries. However, it had all but died out in the neighbouring county of Pembrokeshire by the later 19th century.

Unusually, the earliest recorded post-medieval ironworking sites, dating from the late 16th and early 17th centuries, in both counties survive. This project was initiated to record these surviving sites and to identify new sites associated with the early iron industry. The work was undertaken by Cambria Archaeology and grant-aided by Cadw: Welsh Historic Monuments. An important aspect of the project was the production of first time topographic surveys of three of the earliest sites, the late 16th century furnace at Ponthenri and the 17th and 18th century forges at Llandyfan, Carmarthenshire. The surveys provided up to date information on the condition of the surviving structures and they have allowed recommendations to be made regarding further investigation and the future management of these important sites. Other ironworking sites from the period were also visited and where appropriate new management recommendations have been made.

The potential of these sites for education, interpretation and display was also considered and appropriate recommendations have been made for those sites that are considered suitable.

PROJECT OBJECTIVES

At the outset of this project four main objectives were identified:

1. To examine the origins and character of the early ironworking industry of Carmarthenshire and Pembrokeshire.
2. To provide a detailed structural record of the three surviving examples of early ironworking sites at Ponthenri and Llandyfan.
3. To assess the surviving character and vulnerability of other early ironworking sites whose location is known and, following desk-based research, to attempt to locate other early ironworking sites on the ground.
4. To review scheduling criteria which might be appropriate and provide recommendations for future management strategies.

Objective 1 above can be broken down into a number of individual areas of research:

1. The investigation of the locations and the provision of the ancillary processes of the ironworking industry, such as the supply of ore and charcoal.
2. The investigation, where possible, of the make-up of the workforce of the ironworking industry.
3. To establish and understand, through the investigation of the above the physical and social geographies of the ironworking industry in Carmarthenshire and Pembrokeshire.

Time and resource constraints meant that it was not possible to examine these issues in detail, but the project highlights the potential for further study of these important aspects of the ironworking industry.

METHODS

To achieve the stated objectives it was necessary to develop a varied and flexible, but at the same time structured, approach to the collection and use of the evidence.

The evidence itself, which is fragmentary and often difficult to interpret with any certainty, includes such disparate source material as the physical remains of the ironworking sites themselves, primary historical records, archaeological reports, industrial reviews, published works, local tradition and folk memory.

The starting point for the project was published gazetteers of charcoal blast furnace sites (e.g. Schubert 1957; Riden 1987), which were then supplemented with more regional works (Evans 1967; Evans 1973; Evans 1975). This identified fourteen early post-medieval furnace or forge sites. All the identified sites were then researched further by documentary searches (not all sites had surviving records) and site visits to assess the extent and condition of any surviving features. The sites at Whitland (PRN 8956), Cwmbran Forge (PRN 30669), Furneis Pontiets (PRN 30707) and the possible early furnace on the site of Raby's Furnace (PRN 4491),[1] Llanelli, are no longer traceable. Topographic and photographic surveys were produced of the two forges at Llandyfan (PRNs 4441 and 4446) and the furnace at Ponthenri (PRN 9928): a survey of the Blackpool Furnace (3608), carried out in 1996,[2] has also been included.

Fourteen sites have been considered in this survey (Fig. 1), consisting of four known and two possible pre-1750 furnaces (Table 1) and eight forges (Table 2).

SITE NAME	PRN	SAM/LB	NGR
Ponthenri	9928	Carms 227	SN47410917
Raby's Furnace	4491	Carms 219	SN50390151
Blackpool	3608	Pembs 484	SN06561449
Carmarthen	83	LBII	SN 42082063
Furneis Pontiets	30707		SN478085
Whitland	8956		SN208181

Table 1: Furnace sites.

SITE NAME	PRN	SAM	NGR
Whitland	8956		SN208181
Llandyfan Old Forge	44441	Carms 223	SN65901694
Llandyfan New Forge	44446	Carms 223	SN65631682
Cwmdwyfran	5376		SN41002546
Blackpool Forge	24168		SN06151435
Kidwelly	30668		SN4005
Cwmbran	30669		SN72NE

Table 2: Forge sites.

[1] The well- preserved blast furnace that survives today dates from 1793-1802, but it is thought that operations began on the site during the 1750s.
[2] The survey was undertaken on behalf of Forest Enterprise to determine the extent of the furnace remains for inclusion in their Forest Management Plan for Canaston Wood.

THE DEVELOPMENT AND CHARACTER OF THE CHARCOAL-FUELLED BLAST FURNACE IRONWORKING INDUSTRY OF CARMARTHENSHIRE AND PEMBROKESHIRE

Production of iron using the bloomery

It is hard to underestimate the massive and fundamental changes that the introduction of the charcoal-fuelled blast furnace wrought within the early post-medieval ironworking industry. Until then production was on a relatively small-scale, with the bloomery being the main method of iron production, although the high bloomeries of the later medieval period were able to operate on an industrial basis and they were frequently producing significant amounts of iron.

It is worth outlining the basic method of iron production using a bloomery, as it provides the technical background against which the charcoal-fuelled blast furnaces were introduced. This method entailed heating iron ore with a charcoal charge in a smallish furnace until it was malleable enough to work with hammers. Air was fed into the furnace using bellows, often hand or foot operated, through one or more blow holes around the sides of the furnace, in order to raise the temperature inside the crucible high enough to reduce the iron (Hoover and Hoover 1950, 420; Roberts, 1983, 10-12; English Heritage 2001, 10-11). The temperature reached in such a furnace was seldom high enough to completely reduce the iron to a molten state, although it was high enough to reduce it sufficiently to draw off the slag and therefore remove some of the impurities in the iron. The bloomery produced a lump of malleable iron, the bloom, which was - according to Georgius Agricola in his extraordinary study of post-medieval ironworking in Europe, *De Re Metallica* - beaten with wooden hammers to '*chip off the slags which had until then adhered to it, and to condense and flatten it*' (Hoover and Hoover 1950, 421).

Following this initial processing it was then reheated and beaten with iron hammers on an anvil block to shape it into bars ready for use. Originally carried out by hand, this secondary hammering was, during the later medieval period, increasingly carried out using hammers powered by water wheels (see for example Crossley 1975b). Production of iron in a bloomery was known as the Direct Method because it produced '*in a single process, types of alloy that could be forged by a smith*' (English Heritage 2001, 9).

The introduction of the charcoal-fuelled blast furnace and the use of water-powered alternating bellows

The introduction of the charcoal-fuelled blast furnace and its associated technologies had wide-ranging and far-reaching consequences. It is clear that the new technologies had been developed on the near continent by the mid 15th century, long before they arrived in Britain (Crossley 1981, 37). However, it is also clear that the wealthier ironmasters and operators in Britain would have had knowledge of and probably access to the new technology (Newman *et al* 2001, 187). By the time the first blast furnace was built in Britain at Newbridge, Sussex, in 1496 there were specialist ironworkers skilled in the techniques of iron production using the blast furnaces throughout northwest Europe. Many of those specialists were imported along with the

technology, and this was certainly the case in Carmarthenshire and Pembrokeshire where the earliest works in both counties were established by incomers.

Even though the development of the charcoal-fuelled blast furnace was not the result of a single technological breakthrough, the introduction of the water-powered alternating bellows can perhaps be seen as the biggest factor in its development. The use of water-powered bellows allowed a continuous delivery of air into the furnace, resulting in much greater temperatures inside the crucible. They also allowed continuous production for much longer periods than before. It was not unknown for a campaign (production run) to last up to six months in the Weald (Crossley 1975a, 15), although campaigns of three to four months were probably more normal. As yet no details of the lengths of campaigns have been found for the Carmarthenshire or Pembrokeshire furnaces, although campaigns of similar length to those in England can be assumed.

There are a certain number of fundamental requirements for operating a charcoal-fuelled blast furnace. Rees (1968, 183) described the preferred location for the furnace as '*firm ground near a strong-flowing stream and under a bank against which the furnace could be built to provide an elevated platform.... to enable the furnace to be charged from above*'. Although not all the furnace sites in this study conformed to Rees' ideal, they did all have the one thing that was crucial to their operation, a good and a constant supply of water. A controllable supply of water became increasingly important as the size of the waterwheels increased and water-powered alternating bellows were first introduced to the Weald during the later 15th and early 16th centuries. The importance of water is evident in the surviving ponds, dams and leats at most of the sites in this study.

As well as water a constant and reliable supply of raw materials (ore, charcoal and the limestone used as a flux) were also required at the furnaces and good supplies of charcoal and pig iron were required at the forges. The steady supply of charcoal and other raw materials required extensive and sophisticated landscape management, often by the furnace and forge owners themselves - who in one or two cases were members of the gentry and, therefore, extensive landowners in their own right (Howell 1986, 102-103) - and also by other landowners from whom the professional ironmasters leased *inter alia* woodland, and rights of access to sources of ore.

The introduction of the charcoal-fuelled ironworking industries in Carmarthenshire and Pembrokeshire

The earliest known charcoal-fuelled blast furnace in Carmarthenshire is at Ponthenri (PRN 9928), which appears to have been established sometime during the later 16th century, although the first documentary record of the site comes from the early 17th century. In Pembrokeshire the earliest known site is Blackpool Furnace (PRN 3608), built in 1635 by George Mynne, who constructed the now lost furnace and forge at Whitland (PRN 8956) the following year. Forges were also constructed at Kidwelly (PRN 30668) and Llandyfan (the Old Forge – PRN 44441) during the early – mid 17th century. These are the key sites in the history and development of the industry in the region.

The industry developed steadily rather than spectacularly throughout the 17th and early 18th century, until the widespread use of coke for fuel and steam power meant that the industry could move away from the rural locations that the early industry required. This led to the centralisation of the industry into the hands of fewer, but larger companies and ultimately allowed the development during the later 18th and 19th centuries of the world famous steel and tinplate industries at Carmarthen and Llanelli. The industry in Pembrokeshire never flourished and other than Mynne's furnace at Blackpool and the later Blackpool Forge there are no other known sites associated with the charcoal-fuelled iron industry.

Industrial processes associated with the charcoal-fuelled furnaces and forges

This study considers both furnace and forge sites and, therefore, this discussion includes evidence from both types of site. Some of the requirements, such as the provision of charcoal, water and at least one waterwheel, were similar in both operations. There were, however, fundamental differences between the operations, which were reflected in the layout of the sites, and which should be identifiable in the archaeological record. The forge sites had two key elements not found in a furnace, a waist level hearth (still charcoal fired and heated with air supplied by water-powered alternating bellows) and an anvil with a water-powered hammer. The anvil was typically set in a large wooden block and the hammer was powered by a separate waterwheel to the bellows.

The smelting processes

The basic mechanics of smelting were the same as that used in the earlier bloomeries, inasmuch as the iron ore was still fed into a furnace with a charge of charcoal and limestone. However, the furnace was now much larger and the air was introduced into the furnace by water-powered alternating bellows, which were able to operate continuously and therefore generate much greater heat. The heat generated inside the furnace was sufficient to reduce the ore to a molten state and it was then tapped and run off into moulds in the casting house floor. Reduction of the iron to a molten state allowed the slag to be tapped off more efficiently than in the bloomery, thereby removing more of the impurities in the iron. This method of production was known as the Indirect Method because the resultant cast iron was too brittle to be worked directly from the furnace, so it went from the furnace to a forge where it was reheated and refined in a finery or chafery furnace to make a more malleable and more durable product. However, guns, armoury and, increasingly during the 16th century, '*firebacks and other relatively small and simple cast goods*' (Newman *et al* 2001, 188) could be cast straight from the furnace.

The changes in technology are reflected in the changing nature of the structures required to house the new blast furnaces and their reserves of ore and fuel. It has been estimated that an average early charcoal blast furnace stack would have been in the region of 5m - 6.5m square and up to 6m high (English Heritage 2001, 12). At Ponthenri the remains of the furnace, which is *c*.6.5m square (Fig. 2; Plate 1), still stood up to *c*.7m high in 1983, although, by 1994 only 3-4m survived.[3] This has since been further reduced by modern collapse, and now only the northwest corner stands to

[3] Information from Cadw Scheduled Ancient Monument site visit forms, 1983 and 1994.

a height of *c*.3m (see below for a description of the surviving structures at the Ponthenri Furnace site). The charge of charcoal, ore and limestone was fed into the top of the furnace from a charging platform, which was often located on the first floor of the blowing house or the casting house. The stack structure itself would have had two arches built into it in adjacent walls, the blowing hole, which contained the *tuyères* (bellow nozzles), and the casting arch for casting the iron and tapping the slag. Parts of both arches survive at Ponthenri, although both have collapsed and at present it is unclear which arch was which.

The bellows and water power

Bellows supplied air to the base of the furnace chamber. They were powered by a waterwheel and situated in the blowing house. Early bellows were of fairly standard design, being largely wedge-shaped and made from leather, timber with iron *tuyères* and strapping. The bellows at Llandyfan were considered 'not worth moving' when the forge was closed and its contents removed to Carmarthen in 1807 (Evans 1973, 143). There is good, but indirect, evidence for the bellows at several of the other sites in this study. As well as the blowing arch at Ponthenri, parts of the leats, which supplied water to the waterwheels that powered the bellows or the fining hammer, survive at Cwmdwyfran and Llandyfan and a leat and the wheel pit for the bellows wheel are traceable as slight earthworks at Blackpool Furnace (Fig. 3 and see below for a description of Blackpool Furnace). At Cwmdwyfran, at least during its later life, cylinders rather than bellows are mentioned (Evans 1975, 149), suggesting perhaps that steam was introduced to the works during its later life.

A late 18th century plan of the Llandyfan Old Forge (Fig 4) shows the leat used to power the waterwheels for the bellows and the hammer. The leat was fed through a sluice in the massive dam, which formed a pond to the northeast of the forge (Fig. 4; Plate 2 and see below for a description and survey of the site). A similar arrangement can be seen on a plan of the Kidwelly Forge in 1786, which shows the forge, described in the 17th century as a 'double-forge', situated below a dam, which contained two sluices. The sluices supplied two leats, which ran either side of the forge building (Evans 1967, 33).

Casting

Molten iron could be cast from the furnace into ingots to be sent for re-working into bar iron at the forges, or sometimes straight into its finished form, such as guns or cannonballs. The molten iron was tapped through the casting arch and cast in moulds made in the sand of the casting house floor. The moulds were linked to a supply channel for the molten metal, in the manner of a sow feeding piglets, hence the ingots were known as pigs. The casting arch survived at Ponthenri until recently, but modern collapse has removed most of it, although, the base of the opening probably survives below the rubble. The outline of the casting house appears to survive as a slight earthwork at Blackpool Furnace (Fig. 3) and part of the casting house possibly survives at Ponthenri.

Oliver Cromwell requested cannonballs cast at the Carmarthenshire furnaces, which at the time were almost certainly Whitland and Ponthenri, in 1648 for the siege of Pembroke.

Output

The annual production figures varied between the sites in the study, with some places, such as Cwmdwyfran and Llandyfan, producing around 100 tons per year, whilst Blackpool Forge was producing up to 200 tons per year at its peak (Howell 1986, 104). There are no known output figures for any of the blast furnaces in the study area.

Resourcing the charcoal-fuelled ironworking industry

Ore sources

Within Carmarthenshire the main ore producing areas were associated with the coal field deposits. The 16th century furnace at Ponthenri was, by the early years of the 17th century at least, being supplied from ore pits in the locality worked by the then furnace operator, Hugh Grundy. There is anecdotal evidence, in the form of an early 20th century poem about the founding of the furnace (part cited in Rees 1968, 30), of ironstone extraction on or close to the furnace site at Ponthenri itself, although at present the physical evidence for this is lacking. Clearer evidence for the availability of ironstone in the area comes from a letter written by L B Gwyn of the Glyn Abbey Estate, near Ponthenri, to John Philipps Esq MP, dated 9 April 1794. He wrote '*Being inform'd that there is an Act of Parliament going to be passed for imposing a Duty upon Iron Stone going coast ways from county to county, I trust you will give your support for the benefit of Carmarthenshire, by making the duty considerable, which will oblige Iron Masters to erect their Furnaces where the Iron Stone lies, so that every county may receive the benefit of its own productions*' (Anon 1937, 11). Gwyn's letter came at a time when the iron industry was being centralised into large iron companies and operations in the region were shifting away from the rural areas to Llanelli and Carmarthen with their easy access to the sea and foreign markets. It is clear that Gwyn was concerned about the loss of the potential markets for the ironstone reserves on his estates as a result of cheaper ores being imported from elsewhere, such as the ore that was brought from among other places Ulverston and Barrow in Lancashire to Carmarthen (James 1976, 36; Bowden 2000, 38).

In Pembrokeshire the situation was the same, with the main areas of iron ore being associated with the fringe of the coal measures, ranging from Landshipping across the parishes of Carew, Jeffreyston, Loveston and Reynalton. There may have been an iron mine at Minwear, which could have supplied ore to the early 17th century Blackpool Furnace (PRN 3608) in Canaston Wood, and there are other possible iron mine sites at Ambleston, Manorbier and Amroth. The Ambleston site reportedly had 'slags from ancient iron smelting' present, but the location of this site is now lost[4]. In 1793 William Knox paid for trial excavations on land at his Slebech estate in the hope of finding silver, but it transpired that he had mistaken old iron ore pits for silver mines because of the presence of a white silvery film – known by miners as Iron Blossom - in some of the iron ore (Howell 1986, 108). These iron ore pits are almost certainly associated with Blackpool Furnace. Unfortunately their locations are unknown.

[4] Information from Peter Claughton's excellent webstite (www.exeter.ac.uk/pfclaugh/mhinf/pmbs1) on early iron mines in Pembrokeshire.

The 17th century forges at Llandyfan and Kidwelly are also recorded as obtaining ore supplies. Llandyfan obtained its ore from an area in the upper reaches of the Loughor Valley on a northerly outcrop of the coalfield, that had been exploited since the medieval period (Rees 1968, 311) and Kidwelly acquired its ore from the extensive deposits on Mynydd y Carreg (Evans 1967, 32). The fact that ore supplies are mentioned at both Kidwelly and Llandyfan requires some explanation. It is possible that the ore supplied to Llandyfan was for a late 16th century - early 17th century furnace that is supposed to have stood close to the present forge site. It seems likely that the ore for Kidwelly was in reality for Ponthenri, which was sometimes mistakenly called Kidwelly in the records.

Charcoal supplies

It was a long-held belief that the charcoal-fuelled ironworking industry was the cause of mass deforestation and loss of woodland. This notion appears to have been based on the mistaken assumption that the woodland was felled and burnt, but not replaced (Rackham 1994, 46), rather in the manner of agricultural clearance. The idea has been further fuelled by the use of evidence such as the '*Act that Timber shall not be felled to make Coals for Burning of Iron*' passed in 1588 (Linnard 1982, 69) which almost certainly had more to do with protecting trees for the shipbuilding industry than preventing large-scale deforestation by the iron industry.

That said, the documentary sources show that there were some localised problems caused by overcropping and unregulated removal of timber. For example, complaints were made against George Mynne at Whitland for removing half of Whitland Wood, which was described as the stock timber for the area (Evans 1967, 24). Sixteenth century poems about the loss of woodland in Glamorgan show that there was opposition to the iron industry in many areas because of its heavy use of local woodland (Linnard 1982, 69-70). Furthermore, there is evidence that by the end of the 18th century there was a shortage of cordwood available for use at Blackpool Forge, when Charles Hassell recorded that most of the woodland was oak and that it was managed for charcoal production and bark for tanning, but that good charcoal timber was running out (Murphy and Ludlow 2002). This ultimately forced the forge to close in 1806 (Howell 1987, 322; Thorne and Howell 1987, 368-9). It does seem, however, that on the whole the industry was not a major factor in woodland loss in southwest Wales.

In fact, it is clear that most ironmasters had a great awareness of the importance of maintaining the woodland to ensure the supply of fuel and timber to the furnaces and forges. They were, according to Hammersley (1973, 612-613) at least, '*the first to exploit woodland commercially and to consider some of the problems of arboriculture*'. This may be overstating the case slightly, but as both Hammersley (1973, 597) and Lindsay (1975, 284) rightly point out, a great many, possibly up to 30%, of the charcoal blast furnaces in Wales and England operated for over a century, which simply could not have been possible without sustainable management of the charcoal fuel resources.

Not only were the ironmasters themselves very aware of the need for sustainable management, they were employing experienced charcoal producers, known as

colliers, or wood-colliers (*colier coed*), who were drawing on a long history of woodland management and charcoal production. Managing woodland for charcoal production was a practice that changed little from the medieval period to the height of the charcoal iron industry in the 18th century. In the medieval forest of Wychwood, Oxfordshire, for example, the '*Brushwood and poles for charcoal-making were harvested regularly from its many coppices, which were managed in the usual way by rotational fencing and cutting every twenty years or so*' (Marren 1990, 63). The same system of a twenty year cropping cycle and rotational fencing was in use at Lorn Furnace, Argyllshire, during the later 18th century (Lindsay 1975, 289-291), and at Cwmdwyfran Forge staff were employed in fencing woodland during slack periods (Linnard 1982, 73). In Carmel Woods, Carmarthenshire, during the later 17th and 18th centuries tenants of the Golden Grove estate were expected to plant a number of saplings per year as part of their rental agreements (James and Murphy 1992, 9) in order to maintain the supply of timber and coppiced trees. The latter was used for charcoal to supply Llandyfan Old Forge.

Charcoal supply in Carmarthenshire and Pembrokeshire

It has been estimated that a big 17th century blast furnace could operate indefinitely with managed coppiced woodland of *c.*7,000 acres (Hammersley 1973, 606). The estimates were slightly higher, possibly as much as 10,000 acres, in Scotland because of the colder climate and slower growing trees (Lindsay 1975, 289) and slightly lower at *c.*5,000 acres for the furnaces at Clydach, Glamorgan (Linnard 1982, 73), which supplied pig iron to the forges Llandyfan. Whilst these figures vary according to method of calculation, output of the furnaces and other variables, it can be assumed that the ironmasters at Blackpool, Kidwelly, Ponthenri and the other sites in the study were looking to secure thousands of acres of woodland for their own operations. Obviously, resourcing on such a scale could not be managed in a single area; it was achieved through a network of woodland blocks bought, leased or rented, some of which may have been some distance from the furnace. For many of the Carmarthenshire and Pembrokeshire gentry the sale of charcoal and timber from their woodlands was an important and previously untapped source of income (Howells 1986, 101).

At Ponthenri, it is known that Hugh Grundy, ironmaster, was obtaining charcoal from one Lewis Morgan of nearby Forest, in the early 17th century.[5] Sometime around 1611 Grundy had purchased 200 cords of wood from Morgan (Rees 1968, 231). There is documentary evidence to suggest that the furnace was also using another area of woodland nearby, at Wenallt, to supply charcoal during the later 16th century. A survey of the Duchy of Lancaster Lordships in 1609 describes '*...a ffloreste of his Majestie called the Wenalth, and that the same contayneth twentye Englyshe acres or thereabowts, whereof one acre or there abowts was cut downe and made unto Chark Coles aboute twentye yeares laste paste,...*' (Rees 1953, 207). Kidwelly Forge was also obtaining some of its charcoal supplies from Wenallt, as well as another local wood, Coed y Brenin, during the 17th and 18th centuries.

[5] Lewis Morgan was listed as 'gent' in a list of '*ffreehoulders*' in Llangendeirne parish in 1609. His rent to the Duchy of Lancaster was 5s 6d., and his holdings included part of '*the ffloreste*'. The Duchy of Lancaster survey of 1609 gives the boundaries of the fforeste (Rees 1953, 242), but it is difficult to reconcile them with modern placenames, but it appears to have been in the area to the southwest of Ponthenri in the region of modern Carway.

Charcoal for Cwmdwyfran Forge was obtained from various sources, some in the immediate vicinity of the forge on the steep slopes of the Gwili Valley, and some as far afield as Llandovery and Caio (Evans 1975, 164). A 1741 lease taken by the operator of Cwmdwyfran Forge, Rees Saunders, for a nearby farm may have been designed to augment his existing charcoal supplies (Evans 1975, 153). Some of the charcoal supplied to Llandyfan Forge came from woods belonging to the Edwinsford and Dynevor properties (Evans 1973, 131).

The results of a commission of enquiry appointed to assess a petition from the Company of Mineral and Battery Works in 1636 to erect '*two forges and a furnace*' at Whitland recommended that the operator, George Mynne, be allowed to cut timber and convert it into charcoal within a twelve mile radius of Whitland Abbey (Evans 1967, 23). Mynne was also granted a lease to erect buildings for melting iron at Canaston Wood a year earlier in 1635 and to take timber for the works from the nearby woods.[6] A similar situation existed over a century later, where a lease of 1760 for Blackpool Forge, 0.4km west of the furnace, confirmed on the new owner, Robert Morgan of Carmarthen, '*the right to cut timber in Canaston Wood within four miles of the forge*' (Rees 1968, 311). A possible charcoal burning platform (PRN 30134) has been identified, at SN06661390, on the steep wooded bank of a small stream some 0.9km southeast of the furnace, well within the four mile limit from the forge stipulated in the lease. However, it has already been seen how the lack of cordwood in Canaston Wood was a major factor in the closure of the Blackpool Forge in the early 19th century (Howell 1987, 322; Thorne and Howell 1987, 368-9).

Transport and storage

The long production campaigns of the furnaces had a significant effect on the provision, transportation and storage of resources. The furnaces required a continuous supply of charcoal, ore and limestone, and they had to be available in sufficient quantities to allow for campaigns of several months. This required a range of new structures at the furnace sites, which were paralleled at the forge sites where storage was also becoming a major consideration.

Transport

Charcoal was always burnt close to the felling site, because it was easier to transport than timber. Transport was usually by cart or packhorse, which were either owned by the company, or by locals, employed either on a retainer or as casual labour, who supplied their own carts, horses or sometimes mules. The later records for Cwmdwyfran and Llandyfan forges contain some information on the use of in-house and external transporters.

During the later 18th and early 19th centuries, Cwmdwyfran Forge used packhorses owned and stabled by the Carmarthen Tinplate Works, which also owned the forge at Cwmdwyfran. Likewise, four horses were listed amongst the items on an inventory of property belonging to Llandyfan Forge in 1800. The same inventory also had records of two horses belonging to Rees Thomas, carrier, and for a sum of £3 1s 2d to

[6] Information from Peter Claughton's website at www.exeter.ac.uk/pfclaugh/mhinf/pmbs1

transport 9¼cwt of pig iron, split between two other carriers, Thomas Llewellin and Thomas William (Evans 1973, 152).

An 1801 report into the feasibility of constructing a tram road between Llanelli and Lime Rocks stated that it could be used to transport pig iron to the 'Two established Iron works at Llandevane' (NWL ref: Poster XHE Transport Accession No. PY0442).

On-site storage

Charcoal was stored in large buildings situated close to the furnace. These were sometimes known as charcoal barns, as at Dyfi Furnace, Ceredigion (Dinn 1988, 120; English Heritage 2001, 12). A charcoal store was specifically mentioned at Llandyfan (Evans 1973, 133) and it can be assumed that they were present at the other sites as well. The furnaces would also have had a large store for the ore reserves as well. Building 1 at Ponthenri (Fig. 2) may be a charcoal and ore store, but excavation would be required to test this hypothesis. An inventory from 1800 of the property of the Llandyfan Forge showed that charcoal and timber were also stored off-site, presumably close to the felling and coaling sites, which could be some distance away, until they were required at the forge (Evans 1973, 152).

The finished pig iron was stored in sheds at the furnace and forge sites. Iron stores are mentioned at Llandyfan (Evans 1973, 133) and Cwmdwyfran (Evans 1975, 149) forges, and again it can be assumed that they were present at the other sites as well.

The staff of the charcoal-fuelled iron industry

So far this study has concentrated on the technology and distribution of the iron industry, but has only briefly mentioned the one aspect without which the industry could not operate, its workforce. Without the people to work the furnaces, fell and coal the wood for charcoal, mine the ore and transport resources and the finished products the furnaces and forges could not operate. Therefore, this section will examine the evidence the workforce involved in the production and working of iron in Carmarthenshire and Pembrokeshire to try to develop a social geography of the industry. Some staff were part-time, seasonal employees and so the numbers of staff, direct or indirect, at the various sites varied throughout the year. There is also evidence of increasing craft specialisation within the industry.

The workforce

The workforce are often invisible in the records, only occasionally are people mentioned by name and even then they are not always linked to a specific job, so trying to determine the number and make up of the workforce for individual furnaces or forges is a complex undertaking. There are, however, a number of known positions within a furnace or forge, so we can at least start to gain some idea of the number of individuals likely to be present at any given site.

Of the sites considered in this study only the forge at Cwmdwyfran has good records of the workforce, although, these are from the early 19th century, much later than the main period covered here. However, it is likely that the range of jobs undertaken and the numbers of people employed at any one time was similar throughout the working

life of the forge and, therefore, the Cwmdwyfran records are of interest. In 1808 five men are mentioned working inside the forge: the manager, Thomas Daniel; two hammermen, David James and John Russell; and two finers, William Highley and Stephen Jarrat. These employees were housed in purpose-built cottages; Jarrat had moved with his wife? Jane to Cwmdwyfran from the forge at Whitland (Evans 1975, 150). At Llandyfan an estate rental of 1669 records one John Stephens, 'hamerman' (Evans 1973, 136).

Llandyfan Forge had at least three supervisors, or overseers, during the early 18th century, John Steward, William David and Thomas Coslet. Another named individual, Thomas Evan, was employed at the forge as a stock-taker between 1716 and 1732 (Evans 1973, 142).

Among the other staff mentioned at Cwmdwyfran Forge in the early 19th century were the only two women recorded by name for any period at any of the study sites, Ann Cook and Mary Samuel, who made and repaired sacks for transporting charcoal. It appears from the records that the workforce at the furnaces and forges in Carmarthenshire and Pembrokeshire was predominately, if not entirely male, with women perhaps only involved in the ancillary services. This was not always the case, there are many examples of women employed in the later medieval iron industry, either as part of the workforce, or as iron founders in their own right (Geddes 1996, 101-108) and in the later post-medieval period as owners of ironworks (Newman *et al* 2001, 191). In 1805 the Carmarthen works was employing '*a number of persons, girls and women, as well as men*' and that '*the latter are engaged in the various laborious departments of smelting, milling the plates and tinning*' (Eyre Evans 1917, 61). The women were employed in the tinning department rather than the smelting operations.

The reasons for this apparent marginalisation of women within the early post-medieval ironworking industry are at the moment unclear. Is it a real phenomenon, or is it a bias in the records, that further research may address? Or is it linked to changing social attitudes during the early post-medieval period. That topic is far beyond the scope of this present study, but it could form an interesting area for future study into the changing social politics of the iron industry.

Some of the ancillary services such as charcoal supply and transportation have been mentioned before, but with no discussion of the personnel involved, because in most cases they remain unknown. Occasionally individuals are mentioned, for example, John Samuel, possibly Mary's husband, made the baskets used by the charcoal burners at Cwmdwyfran Forge in the early 19th century (Evans 1975, 163). It is probable that the sacks made by Mary Samuel and Anne Cook and the baskets made by James Samuel were only for charcoal supplied from the forge's own woods, with other, commercial colliers delivering charcoal in their own sacks.

Little is known of the wood colliers employed during the 16th - 18th centuries, but more recent contemporary descriptions of the charcoal industry and the lives of the colliers do survive. These, with the usual cautions about using ethnohistorical data from later periods to inform about the past, can be used to gain some insight into the organisation of the early post-medieval charcoal industry. Wood was felled and corded during the winter and early spring and coaled during the summer (Linnard 1982, 71; Jenkins 1976, 79). More people were employed in the felling and cording of

wood than in the coaling process, not only because it was a specialist craft, but also because many people would have been unavailable during the summer as they were engaged in agricultural activities. One of the most specialised employees involved with the supply of charcoal was the measurer of cordwood. There were three such specialists living in Llandybie parish during the early 18th century who measured wood in Wenallt Wood, possibly for Kidwelly Forge or Ponthenri Furnace, and who may also have been employed at the Llandyfan Forge (Evans 1973, 142).

Much of this work was carried out by men, although on occasion whole families were involved (Linnard 1982, 74), particularly at the coaling stage, when the colliers and their families would live in the woods full time tending the clamps and bagging the finished charcoal.

The records show that the skilled furnace and forge staffs were retained for as long as possible, often on general maintenance and repair work. Cwmdwyfran forge closed down during slack periods and its skilled men were put on to other jobs that, early in the nineteenth century, included tree planting, felling, and fencing of woodlands (Linnard 1982, 73). An inventory of the stock and liabilities of Llandyfan Forge, undertaken in 1800, also records many payments for works carried out on the forge's woods (Evans 1973, 152).

A corollary of the increased use of specialist staff was the provision of supplied housing at the furnaces and forges. Worker housing was mentioned at Llandyfan New Forge and Cwmdwyfran Forge and its is likely that there was also housing at Ponthenri Furnace (the domestic building) and at Llandyfan Old Forge (possibly Building 3).

The scale of the pre-1750 ironworking industry and the use of imported specialist staff meant that it was not a significant employer of local people in either Carmarthenshire or Pembrokeshire, although clearly some local opportunities were generated. It was the development of the steel and tinplate industries during the late 18th and 19th centuries that created an employment boom, particularly in Carmarthen and Llanelli, both of which became world leaders in the manufacture and export of tinplate.

THE SURVEYS

Three sites were surveyed during this project, the Old and New Forges at Llandyfan (PRNs 44441 and 4446 respectively) and the furnace at Ponthenri (PRN 9928). A survey of Blackpool Furnace (PRN 3608) undertaken in 1996 has also been included.

BLACKPOOL FURNACE (PRN 3608)

Location

The site of Blackpool Furnace is in the Forest Enterprise owned Canaston Wood at SN06561449. The site was clear-felled in the early 1990's and today the area is protected as a Scheduled Ancient Monument (Pembs. 484).

History

A charcoal-fuelled blast furnace was erected at Canaston Wood in 1635 by George Mynne, an ironmaster who already had extensive ironworking interests in the Wealdon district of East Sussex and Kent and in the Forest of Dean before moving to Pembrokeshire. He erected another furnace and a forge at Whitland the following year, 1636.

In the lease for the furnace, Mynne was granted the right to take timber and cordwood for the works from the nearby woods. A similar situation existed over a century later, where a lease of 1760 for the nearby Blackpool Forge, 0.4km west of the furnace, confirmed on the new owner, Robert Morgan of Carmarthen, '*the right to cut timber in Canaston Wood within four miles of the forge*' (Rees 1968, 311). The site of a possible charcoal burning platform (PRN 30134) has been identified, at SN06661390, on the steep wooded bank of a small stream some 0.9km southeast of the furnace, well within the four mile limit from the forge stipulated in the lease.

Ore for the furnace was available locally. There may have been an iron mine at Minwear, which could have supplied ore to Mynne's furnace, and there are other possible iron mine sites at Ambleston, Manorbier and Amroth. The Ambleston site reportedly had 'slags from ancient iron smelting' present, but the location of this site is now lost. In 1793 William Knox paid for trial excavations on land at his Slebech estate in the hope of finding silver, but it transpired he had mistaken old iron ore pits for silver mines because of the presence of a white silvery film – known by miners as Iron Blossom - in some of the iron ore (Howell 1986, 108). Those iron ore pits were almost certainly associated with the Blackpool Furnace in Canaston Wood; but unfortunately their locations are unknown.

It is not clear at present how long the furnace, or its associated forge operated, but they had seemingly been abandoned by the time the Blackpool Forge (PRN 24186) was constructed in the 18th century. Blackpool Forge operated until a lack of cordwood in Canaston Wood forced its closure in the early 19th century (Howell 1987, 322; Thorne and Howell 1987, 368-9).

The site (Fig. 3)

A survey carried out in 1996 revealed a series of low earthworks and terraces that are the only standing remains of the furnace and its associated buildings. The terrace sits above a small stream, which forms the eastern edge of the site. At the time of the 1996 survey some of the earthworks of the furnace structures were low, but relatively free of vegetation, and it was possible to trace the outline of what appears to be the furnace and the blowing and casting houses. The traces of the furnace and its buildings are difficult to locate on the ground now, but the line of the leat is traceable for some distance across the site and the tailrace is visible through the wooded area to the northwest.

The leat (PRN 44451)***, wheel pit and tail-race*** (PRN 44452)

The leat entered the site from the south. It brought water from the stream and originated at a point somewhere near the current bridging point on the track to Eagle Lodge[7]. The leat is visible as a slight hollow, *c.*1m wide in places and it is generally hard to follow once outside the southern edge of the furnace site. It approaches the furnace itself from the southeast and it appears to curve west, before turning to run north along the west wall of the furnace.

Slight earthworks surrounding the southern end of a rectangular hollow on the 1996 survey, appear to be the remains of the wheel pit for the bellows wheel. The tailrace is visible from 2m north of the hollow, which may in fact be the point at which the race exits the north end of the wheel pit. The tailrace survives as a well-defined hollow, c.1m wide running northwest from the furnace and through the wooded area to the northwest. It has been noted running towards the Blackpool Farm, 0.5km to the southeast of Blackpool Mill[8], which may have been the site of a finery forge built by Mynne to process the iron from the furnace.

The furnace

The likely position of the furnace is indicated by the line of the leat and tailrace and the possible wheel pit. Assuming that the identification of the hollow as a wheel pit is correct it is possible to speculate on the layout of the furnace structure. Two low banks, *c.*3m long, 2m east of and parallel to the possible wheel pit, may be the wall lines of the blowing house, or even the base for the bellows. This means that the furnace would have been to the north of this area, probably in the southwest corner of a sub-rectangular area defined by another low bank. Part of this area may also have been used as the casting house.

Other features

There are some mounds and terraces that contain slag to the northeast of the furnace and several field boundaries were also recorded in 1996.

[7] Information from Peter Claughton's website, www.exeter.ac.uk/pfclaugh/mhinf/pmbs1
[8] Information from Peter Claughton's website, www.exeter.ac.uk/pfclaugh/mhinf/pmbs1

Condition

The scheduled area lies in a clearing that is excluded from active forestry operations, although extensive natural regeneration and self-seeding is occurring. The site is completely covered in brambles and numerous young, self-seeded trees are beginning to establish themselves. A path has recently been cut, possibly by Forest Enterprise, through the brambles, presumably in an effort to locate the site, although apart from a small section of the field boundary that forms the southern edge of the Scheduled area, no other features were visible (Plate 3).

Without intervention the trees will once again become well established on the site. The bramble cover renders the site invisible.

PONTHENRI FURNACE

Ponthenri is the earliest known charcoal-fuelled blast furnace in Carmarthenshire. First mentioned in the early 17th century, but likely to date from the later 16th century, the furnace operated until the early 18th century.

Location

The remains of the furnace are located at SN47410917. It stands in a wooded area on a modified terrace on the west bank of the Gwendraeth Fawr river. The terrace is defined on its north side by a low bank that leads to a plateaux that extends for several hundred metres, roughly parallel with the river. It was this terracing that made the site suitable for the construction of the furnace, which was built into the base of the bank.

History

The first known mention of the furnace is in 1611, when Hugh Grundy, ironmaster, was obtaining charcoal from one Lewis Morgan of nearby Forest[9]. Sometime during that year Grundy had purchased 200 cords of wood from Morgan (Rees 1968, 231). However, as noted above, a reference in a survey of the Duchy of Lancaster Lordships, carried out in 1609 suggests that the furnace was operating and obtaining charcoal from other woodland, at Wenallt, by the later 16th century. Anecdotal evidence in the form of an early 20th century poem (part cited in Rees 1968, 30), describes the founding of the furnace by a Swedish ironmaster ('*Haiarnwr o Sweden*') in the reign of Elizabeth I (1558-1603), but its exact foundation date is unknown. The poem states that the Swede constructed a furnace, a smelting house, a waterwheel and two bellows as well as establishing an ore mine (Evans 1967, 30). It concludes that the furnace supplied cannon balls for the war against Spain and that the Swedish ironmaster was successful enough to build a mansion house.

At the death of the Swedish founder the furnace was closed before apparently being reopened twenty years later by a Cornishman (Evans 1967, 31), probably Hugh Grundy. The furnace was closed in 1629 due to a dispute between Grundy and Walter Vaughan, over a piece of land called *yr Rhace* (the race), which was crossed by the leat carrying water to the furnace. A judgement went in favour of Vaughan and the leat was 'turned out' (Evans 1967, 31). It is not clear when production started again, but it is thought that the furnace may have produced cannonballs during the Civil War. The furnace eventually passed to Hugh Grundy's granddaughter, Lucy, who married Anthony Morgan. It is not clear whether the Morgan family operated the furnace themselves, but in 1696 Thomas Morgan and his mother Elizabeth leased the furnace to Thomas Chetle (Evans 1967, 32; Riden 1987, 5). This is the first mention of the Chetle family in the Carmarthenshire iron industry, although eventually they expanded their interests to include the forges at Llandyfan, Whitland and Kidwelly.

---

[9] Lewis Morgan was listed as 'gent' in a list of *'ffreehoulders'* in Llangendeirne parish in 1609. His rent to the Duchy of Lancaster was 5s 6d., and his holdings included part of *'the ffforeste'*. The Duchy of Lancaster survey of 1609 gives the boundaries of the fforeste (Rees 1953, 242), but it is difficult to reconcile them with modern placenames, but it appears to have been in the area to the southwest of Ponthenri in the region of modern Carway.

It was around this time that a new furnace is thought have been built at Ponthenri (Riden 1987, 5), close to the site of the original furnace (Evans 1967, 30). However, it is not clear from the published sources where the evidence for this rebuilding comes from, nor what form the evidence itself takes. Evans (1967, 30) mentions the possibility that the earlier furnace may have stood some 50m upstream of the present site, and examination of the area during this survey revealed a possible leat, which was shown on the Llangendeirne parish tithe map of 1846 and large amounts of slag, although this could easily have been transported and dumped from the present furnace.

The possible site of another furnace, Furneis Pontiets (PRN 30707), demolished in the 19th century has been identified near Ynys Hafren, some 1km south-southeast of Ponthenri (Evans 1979, 16; Riden 1987, 6). Was this the site of the new furnace, possibly built to escape the problems of water supply at Ponthenri? The site is described in more detail below. In 1697, the year after Chetle leased the furnace, an agreement was reached between the Morgan and Vaughan families, which guaranteed the continuation of the water supply over the land called yr Rhace for 99 years. Therefore, if the Pontiets site was the new furnace, it was presumably not built because of problems with the water supply, although construction on the new furnace may have already begun. Again, if this was the new furnace, then it means that the Ponthenri Furnace is the original late 16th century furnace. It has to be pointed out that the Furneis Pontiets may not be associated with Ponthenri at all, and it may be an undocumented independent enterprise.

In 1717 Ponthenri furnace, perhaps at the time wrongly called Kidwelly, was producing 100 tons of pig iron per year and in 1729 Peter Chetle sold all his Carmarthenshire iron interests to Lewis Hughes of Carmarthen. By 1747 the furnace had come into the possession of Robert Morgan, who opened a furnace at Carmarthen the same year. There is no record of when production ceased at Ponthenri, but sometime around the time of its transfer to Robert Morgan would seem reasonable.

The site (Fig. 2)

Substantial remains of the furnace, and other buildings survive on the site. One of the buildings appears to be domestic in nature and it survives in part to full gable height. It also retains some of its internal detail. There is no clear evidence for the water supply to the furnace, although post-abandonment changes to the site may be obscuring such features. This also makes interpretation of the layout of the furnace and casting and blowing houses difficult.

The furnace

A reasonably large section of the furnace survives, aligned with its corners on the cardinal compass points. The west corner of the structure survives to a height of *c.*3m above present ground level, but it seems likely that there is at least 1m more below ground. The ground level around the furnace has been raised and it now stands at the point where the northwest side of one of the arches springs from the furnace wall. Fairly recent collapse has occurred on the south and east corners of the structure, where the two sides of the other arch have fallen. This has obscured any surviving standing masonry in this area (plate 4).

The furnace is constructed from coursed, shaped masonry blocks, some of which are large rectangular stone slabs, up to 1m x 0.7m x 0.2m thick. The blocks are well bonded with a pinky white, soft mortar with many small stone inclusions. Part of either the blowing or casting arch, which was segmental with stone voussoirs, is visible in the southwest wall, although the arch itself has collapsed and the fallen masonry now fills the space of the arch. The other arch was in the southeast wall, but this too has collapsed and is obscured by fallen masonry.

Lack of any clear evidence for the water supply to the site makes it difficult to understand the operation of the furnace, for example which arch was which. This crucial and fundamental information to understanding the layout of the site and how the furnace operated. There were set requirements for operating a blast furnace, and principal among them was a waterwheel to operate the bellows. The wheel was set on the outside wall of the blowing house, parallel to the bellows, which fed air into the furnace through *tuyères* set in the blowing arch. At Ponthenri the blowing house must have been on the southeast or the southwest side of the furnace, so there are two likely locations for the wheel. If the blowing house was on the southeast side of the furnace then the wheel would have been on its northeast wall, and if the blowing house was on the southwest side of the furnace then the wheel would probably have been on its northwest wall.

The higher ground to the north and northwest of the furnace structure does not appear to have been cut through by a watercourse and there is no obvious tailrace feeding back into the river. Furthermore, the references to the 17th century leat crossing *yr Rhace* are too vague to be of use in pinpointing the water supply, if they even refer to this site (see above). Excavation in front of either arch of the furnace would supply the answer to this crucial question.

There is no doubt that the high ground to the north of the furnace would have been the site of the charging ramp, although no above ground evidence for it survives. However, it is possible that there may be some below ground remains that may indicate the form that this structure would have taken

The domestic building

This building is rectangular, 6.5m x 5m, aligned northeast – southwest and it formerly had a gabled roof (plate 5). The northeast gables stands close to its to full height, 4m, but the northwest and southeast walls have suffered severe collapse and the uppermost 1m of the southwest gable collapsed during a spell of very bad weather during this survey. The northwest side of the building is cut into the bank that defines the north side of the site terrace.

The building is constructed from squared blocks, mortared with a very degraded off-white mortar that contained charcoal fragments, broken hazel nutshells and small stones. Some of the charcoal fragments were quite large and their presence suggests that this building was constructed after the furnace began production. There is an opening, a probable doorway, in the centre of the southeast wall, which appears to have been approached by at least one step. The northeast gable also contains a

doorway, which retains its wooden frame, and a central window towards the top of the gable. There is a small window at mid height towards the north side of the west gable.

Internally the building has a rounded west corner, which retained some plaster with traces of white paint. The curve of the interior wall continued into the side of a rectangular structure, now virtually demolished and obscured by tree growth that occupied the southwest corner of the building. This structure retained a wooden lintel above an opening in its east side. The opening was blocked by falling masonry and tree growth.

Externally part of a small rectangular extension, possibly an outside toilet, 2m x 2.5m, survives on the northeast end of the east gable wall. A small stone-built structure, 1.5m x 0.75m x 0.6m high, on the southwest gable wall formerly had a pitched stone tiled roof that was keyed into the wall and therefore, a part of the original design of the building. This structure was possibly an oven, which was apparently blocked during some form of internal re-ordering.

The building sits in an enclosure formed by the part of the northwest-southeast wall that flanked the west side of the main entrance track into the site. Another short length of stone wall extending northwards from the northwest corner of Building 1 forms the southern end of the enclosure wall, which is shown complete on the Ordnance Survey 2nd edition 1:2500 map of 1915. The separation of this building, which has clear domestic features, from the rest of the site suggests that it was accommodation of some kind, possibly the manager's house, with a small garden plot. It may also have functioned as the office.

Building 1

The remains of a northwest-southeast stone-built building that measures 16m, x 5m. It is constructed from shaped stone blocks bonded with a soft, pink - off-white mortar with small stone inclusions. The building consists of two rooms, a northwest room measuring 5m x 4m internally, and a larger southeast room, 8m x 4m. The northeast wall faces onto the track that runs northwest – southeast through the site.

The nature of the former openings in the northeast wall is unknown, but there are some blocked openings in the southeast and southwest, rear, wall that seem to have been single-width doorways, and the lower part of a window with flared reveals was also present in the southwest wall. At present the former function of this building is unknown, although its use as a charcoal and ore store would seem unreasonable.

Structure 1

Structure 1, *c.*11m x 6m, extends southwest from the south corner of the furnace. Three sides of the building survive (plate 6). The two end walls (the northeast and southwest walls) may have been open. There appears to be an opening in the southwest wall, now blocked by fallen masonry, and the southeast wall flares outwards at its northeast end to form a funnel shaped opening in the northeast wall. A short length of stone wall may have formed the other side of the funnel, but this is uncertain, as the stones were only partially visible beneath the collapsed masonry of

the furnace. Therefore, it was impossible to be certain if they were *in situ*. An opening in the northwest wall has at least one step down into the interior.

There was no above ground evidence to indicate a function for this structure, but the funnel-shaped opening on the northeast side is suggestive of water management.

The trackway or hollow way

A well-defined trackway runs northwest – southeast through the site. It leads from the farm to the northeast of the site, but its northern end has been partially infilled by modern dumping and levelling of the ground to the north of the site. The northern end of the surviving track has a stone wall flanking its southwest side, and sections of walls were also recorded on the northeast side and on the southwest side towards the southeast end of the track.

The track varies in width from approximately 5m wide at its northwest end, where it enters the site, it narrows to *c.*3m wide where it runs alongside the northeast wall of Building 1, before widening to its original width at the southeast end.

The spoil heap

The main spoil heap, composed of green glassy slag typical of smelting using limestone as a flux, is located to the southwest of the site. It measures *c.*40m x 18m x 3.5m high and it is estimated to contain *c.*2,500 tons of slag. A retaining wall runs along the west and part of the northwest sides. Another short length of wall constructed on the southwest end of the spoil heap is probably part of a later field boundary.

Not surprisingly there is a large amount of slag spread over most of the site, with large amounts on the higher ground in the area just north of the furnace.

Other features

A well-defined platform to the north of the domestic platform has a large amount of masonry along its west and south sides. A building was shown in this vicinity on the Llangendeirne tithe map of 1841, but it is not clear if it was associated with the furnace, or whether it was a later agricultural building for Furnace Farm, 50m to the north.

Condition

The site is generally in a fairly stable condition, there are specific problems, outlined below, but overall its condition is good. Tree growth is extensive across the site (Fig. 5) with a mixture of mature trees, some regenerating coppiced stands and developing understorey vegetation, which are putting increasing pressure on the archaeological remains. Modern dumping has been occurring in the area east of the furnace and to the north of the site, including the northern end of the trackway. These areas are currently outside the scheduled area.

The furnace structure has deteriorated considerably over the last fifteen years or so. A site visit carried out by Cadw in the mid 1980s reported that the furnace stood to a height of *c.*7m, but by 1994 it had been reduced in height to 3-4m. Recent collapse of the southeast and southwest corners has further reduced most of the structure to a height, above ground level, of less than 2m, and removed most of the facing stones leaving parts of the core work exposed. The northwest corner survives to 3-4m and it is held together by the roots of a large tree that is growing on top of the structure (Plate 7). There is no doubt that when the tree dies the structure will collapse, but it is worth pointing out that as the structure collapses on itself the falling masonry is protecting the lower levels of the furnace from further damage.

The gable walls of the domestic building are very unstable and at least 1m was lost from the top of the southwest gable during this survey (Plate 8). A large tree growing in the southwest corner of the interior is pushing the southwest gable wall outwards as well as destroying the internal fixtures. The northeast gable is ivy covered. Any fixtures or fittings at floor level will be protected by the large amounts of rubble inside the building.

Building 1 is fairly low and the surviving walls are reasonably stable. There are some trees established on the walls, which are having a deleterious affect on the structure of the walls, and several large trees growing close to the rear, southwest, wall will put increasing pressure on that side of the building. The floors are covered with rubble, which should protect the floors and any low level fixtures and fittings from further damage. Likewise, the northwest wall of Structure 1 has some large trees growing on it, which will eventually fall and remove sections of the surviving masonry. The southeast wall is at ground level and reasonably stable. A layer of wet, organic rich humic soil of unknown depth covers the interior of the structure.

Cattle shelter on the slagheap and they are causing some erosion around the base and to the south side of the mound. Some large trees are growing on the top and sides of the mound. The damage to the slag heap from the cattle or trees is not considered significant at this stage, but future monitoring should be undertaken.

FURNEIS PONTIETS

Location

The site is centred on the remains of an old farmhouse, Hen Ffwrness, near Ynys Hafren, at SN47850860. The former presence of a furnace (PRN 30707) is indicated by mid-18th century field names, such as 'The Old Furnace Yard' and 'llain yr Hen Furnace' (CRO: Stepney mapbook, 1761). Smelting slag deposits mark the site today, although there are no apparent standing remains of the furnace or its associated structures.

History

This furnace is almost totally unknown and so far no contemporary references to it have been found. It is interesting to note that in the mid-18th century (1761) field names referred to the old furnace, suggesting that it had already been abandoned for some time. A local history published in 1905 (Thomas 1905) refers to a smelting house close to an old farmhouse, Hen Ffwrness, which obviously takes its name from the furnace. The remains of the farmhouse are visible today, and it is thought that the furnace was located just to the southeast. Thomas recalled the stones from the furnace being taken within his lifetime, so sometime during the later 19th century, but interestingly no buildings, other than Hen Ffwrness, are shown in this area on any of the early Ordnance Survey maps, nor the Llangendeirne parish tithe map of 1846.

It is not clear what, if any relationship this furnace had with the operations at Ponthenri, a short distance to the north-northwest. However, it is tempting but conjectural to suggest that this was the new furnace, which is said to have been built sometime after 1696-7, when Thomas Chetle took over the works at Ponthenri. The suggested date of abandonment, prior to 1761, would fit with the supposed date of the end of production at Ponthenri, the late 1740s, when the then operator, Robert Morgan built a new furnace at Carmarthen. However, it could equally be earlier than, or contemporary with the Ponthenri furnace and any further speculation is purely conjectural at this stage and much more work is required on this site before it can be fully included in the history of the charcoal-fuelled iron industry in Carmarthenshire.

The site

The site stands on the wooded slopes of the narrow valley containing the Afon Hafren. There are no above ground remains that can be definitely attributed to the furnace, although several old watercourses and terraces are visible in the vicinity.

Previous small-scale investigation of the site (Evans 1979, 16) revealed several leats leading from the Afon Hafren towards Hen Ffwrness and deposits of 'iron slag incorporating charcoal'. The remains of possible dam were also recorded on the Afon Hafren, although this could be related to later coal mining or brick making, which were also carried out in the area. A recent visit to the site recovered several lumps of green glassy slag, typical of slag from a smelting furnace using limestone as a flux, which had been incorporated into the enclosure for Hen Ffwrness farmhouse.

THE LLANDYFAN FORGES

There are two forges at Llandyfan, the Old Forge (PRN 44441) and the New Forge (PRN 44446). Between them they operated for over 150 years

LLANDYFAN OLD FORGE

Location

Llandyfan Old Forge sits on a low terrace on the north bank of the Afon Loughor in the upper reaches of the Loughor valley (at SN65881695), in southeast Carmarthenshire. The site covers a total area of 0.9ha (2.3 acres), of what is now unimproved pasture and woodland.

History

Michael Evans produced a fairly comprehensive history of the Llandyfan forges in the early 1970s (Evans 1973) and this summary relies heavily on that work.

The foundation date of the forge is unknown, and the earliest known reference to it is in a rental from the Golden Grove estate, when in November 1669 it recorded 'a parcel of land bought of Sir Henry Vaughan adjoyneinge the forge' (Evans 1973, 136). An entry in the same rental also records one of the estate tenants, John Stephens, as a 'hamerman', who was presumably employed at the forge (Evans 1973, 136). It is possible that the forge was intended as an outlet for pig iron produced at a nearby furnace that had been abandoned by 1756 (CRO Cawdor 5570). The site of the furnace is not known, but surviving correspondence indicates that it was on or close to the forge site (Evans 1973, 146). A second ironworking site shown on Emmanuel Bowen's 1729 map of South Wales may refer to the Llandyfan furnace, or to another furnace that was thought to have operated in the area during the later 17th or early 18th century (Evans 1973, 146). However, inaccuracies in the positioning of the works on Bowen's map – they have been shown on the wrong side of the River Loughor – demand a cautious use of this evidence.

The forge was constructed on land owned by Sir Henry Vaughan of Derwydd, but there is no evidence to suggest that he ever operated the forge himself. It is more likely that he leased out the land and encouraged the construction of the forge, and possibly the now lost furnace, as a way of securing timber sales from his extensive woodland holdings. Likewise, the Vaughan's of Golden Grove probably acquired the forge from their relatives at Derwydd as an outlet for their timber, which would also account for their interest in the Kidwelly forge at the same period (Evans 1967, 34-35). It has already been seen that the burgeoning charcoal-fuelled ironworking industry was as an important outlet for timber from the extensive woodlands of many, if not most, of the estates in Carmarthenshire and Pembrokeshire. As well as the Golden Grove estate, Llandyfan Forge also acquired charcoal from the Dynevor and Edwinsford estates. See above for a discussion of the charcoal supply in Carmarthenshire and Pembrokeshire.

Records for the early working of the forge are few and confined to estate rentals and lease agreements, allowing a chronology of tenancy, but no real assessment of the

operation of the forge. The earliest known lessee of the forge is William Davies, who during the later 17th century also held the lease of Kidwelly forge (Evans 1973, 137). By 1702 the lease had been reassigned to William Spencer of Carmarthen who obtained a fifteen year lease on the forge. An inventory drawn up when Spencer took the forge listed amongst other things '*The Iron and all Geers for the Chaffery and finery Bellows & and every Materiall, old Bellows Nayles w^t^*' (Evans 1973, 148). This is the earliest record of what the forge contained, and it clearly shows that the forge was operating both chafery and fining hearths.

The rent of £33 that Spencer was paying was considerably less that the £60 paid by the previous tenant, possibly a Mr Astrey. Spencer was also granted £30 for the repair of the forge (Evans 1973, 137) and it seems clear from this that by the end of the 17th century the forge was in a state of some disrepair. Spencer did not see out his fifteen year lease and by 1712 the forge was leased by Thomas Chetle, although it was his son Peter who was responsible for running the forge. Peter Chetle was by this time already controlling operations at the furnace at Ponthenri, which the Chetle family had leased from Thomas Morgan and his mother in 1696 (Evans 1967, 32). Peter Chetle did not renew the lease on the forge when it expired in 1715.

Two local landowners took up the option on the forge at an annual rate of £22 10s 0d (Evans 1973, 138), much lower than the £33 paid by Spencer and the Chetles before them. Llandyfan is mentioned in a 1717 list of forges and furnaces operating in Wales and England as producing 20 tons of iron per year, well short of its estimated potential of 100 tons per year. The reduced rent and the low annual output may be a reflection of the state of the early 18th century Carmarthenshire iron industry, which appears to have been in a state of decline. A further and more serious slump occurred in the 1730s when the forge was forced to close (Evans 1973, 138).

The forge was in a ruinous state by 1739 and despite some repairs to the roof massive repair works were still required when the forge was leased to Thomas Popkins of Forest, Swansea, in November of that year (Evans 1973, 139). Popkins leased the forge at a rent of £22 10s 0d, although for the first year the rent was charged at the nominal figure of 12s in order for him to effect the repairs. He operated the forge until at least 1750, by which time it was producing 100 tons per year. By 1752 the lease, at the same rent, had been assigned to Thomas Price of Cwrt-rhyd-hir near Neath (Evans 1973, 139). An upturn in the iron industry during the middle of the 18th century is reflected in the vastly increased annual rent of £42 charged when Price renewed his lease in 1757.

Price held Llandyfan until 1777, when a local partnership operated the forge at an increased rent of £50. The partnership, between a Llandeilo shopkeeper, John Griffiths, and William Roderick, had been dissolved by 1790 leaving Roderick in sole control of the forge. This was a crucial period in the history of the Llandyfan Forges, for it was sometime around the later 1780s that the New Forge appears to have been constructed on land leased by Roderick. It is possible that he constructed the New Forge on land he already leased in an attempt to circumvent another increase in the rent for the Old Forge, which by 1798 had increased to £70.

From 1800 onwards the Old Forge was leased by John Morgan & Company of Carmarthen (Evans 1973, 142). This effectively completed the monopoly of the

Carmarthenshire ironworking industry by the Morgan's iron and tinplate business, a situation that the Golden Grove estate had fought against during the 1750s in an effort to protect the price of timber and cordwood. Morgan was the last operator at the Old Forge and a serious flood sometime around 1807 led to its final closure.

Llandyfan processed pig iron from Clydach and Ynyscedwyn furnaces near Swansea. The Ynyscedwyn Furnace operated from around 1711 until the later 19th century (Roberts 1983, 32).

The site (Figs 4, 6, 8 and 9)

Substantial remains survive on the site, with many identifiable structures. The most prominent and dominating structure is the massive dam that divides the site into two, with the pond to the northeast and the forge buildings to the southwest. Other structures survive in various states of collapse. The forge building itself, for example, retains some standing walls, whilst the rest of the structures can be traced in outline as vegetation covered mounds and banks. There is a large amount of masonry strewn across the site, from the demolition and collapse of the forge buildings, which in some areas made the identification of the *in situ* remains of buildings difficult.

Some areas are becoming increasingly boggy, with up to 0.2m – 0.3m of waterlogged, organic rich soil having developed across the central section of the site. The area containing the forge buildings is heavily wooded, with mature trees growing on most of the structures. Many of the trees have been coppiced in the past, indicating some woodland management, but there is no longer any active management of the site and its condition is deteriorating as a result.

The pond (PRN 44442: Figs 4 and 6)

The area marked simply as 'pond' on a 1789 plan of the site lies to the northeast of the dam. Today, this area is a grass field with several large wet hollows along its south side. The field slopes from northeast to southwest, towards the sluice in the dam and the River Loughor. A large bank (Fig. 6, No. 1), *c.*30m x 15m x 2m high, presumably to retain the water in the pond, runs along part of the south side of the field. The bank is separated from the dam by a narrow wet hollow, 4m wide, which was probably an overflow channel.

On the 1789 plan the River Loughor is shown flowing straight into the top of the field, but there is no sign today of how the water filled the pond. It is possible that construction of the new bridge at the east end of the pond field has removed evidence of any former sluices or channels. Water from the pond was also used to supply water to the New Forge, some 300m to the southwest, via an open roadside channel, which has been gradually filled in over the last 20-30 years.

The dam (PRN 44443: Figs 4, 6, 7, 8 and 9)

This structure appears to survive to its original size, *c.*64m x 7m x 4.5m high. The dam, which is aligned northwest - southeast, was constructed as an earth and rubble bank faced on both sides with substantial stone walls, which have a 10-15 degree slope (Fig. 7). It was first shown on the 1789 plan of the forge as a massive structure

with two rectangular notches in its northeast, or pond side. The notches shown on the 1789 plan (Fig. 4) correspond to two openings in the dam. One is a stone-lined sluice, which carries a leat to the forge, and the other is now blocked and its original form and function is unclear. Neither notch on the 1789 plan extended through the width of the dam, suggesting that they may have some form of walkway, presumably timber, over them in the past.

The sluice, which divides the dam into two (plate 3), carries a leat that took water from the pond to the northeast of the dam and runs alongside the forge where it powered at least one waterwheel. A possible wheel pit has been identified alongside the forge (Fig. 6 and see below). The sluice is funnel-shaped, tapering from *c.*3m wide at the northeast end to 1.5m wide, where the water exits on the southwest side of the dam. The exit of the sluice projects 1m – 1.5m out from the face of the dam. The projection on the northwest side has a rounded northwest corner, whilst the southeast projection is much larger and rectangular.

Both the angled walls of the sluice have a step, just above the present water level, which stop at the point the walls straighten and become parallel. Neither of the angled walls, above the steps, appear to have been faced in the same way as the sluice exit projections, or the dam faces. However, there has been some collapse and tree damage to the sluice walls, which may well have removed the facings.

The blocked opening is 10m northwest of the sluice (plate 9). Tree growth and the collapse of the dam faces at this point make it difficult to be certain of the original form of the opening, but the northeast, or pond side does flare out, suggesting a funnel-shape similar to the sluice. The southwest side of the opening has a projection, similar to the sluice, which appears to be butt-jointed to the face of the dam. The opening is very solidly blocked by a large amount of masonry and debris, much more than could possibly have collapsed from the dam structure. This clearly indicates deliberate blocking of what was probably a second sluice, but when and why it was carried out is unclear.

A rough estimate of c.2000 tons has been made for the amount of material required for the core of the dam. This excludes the significant tonnage of stone required for the facings. There was no evidence that the material for the dam was taken from close to the site, so it must have been imported from elsewhere, and the quarries on the hills to the north and northwest of the site may have been a source.

The leat (PRN 44444)

Water still flows freely along the leat from the pond, past the forge and into the River Loughor, 40m downstream from the forge. For most of its length it is still confined to its original course, although an obstruction just below the sluice exit has caused the water to pond at this point and form a new channel, which loops north for a short distance before returning to its original course. The leat is *c.*1m wide for most of its length, although obstructions and erosion have acted to reduce or widen it in places. On the 1789 plan of the forge a wall is shown running along the south side of the leat, and a short length of wall recorded towards the southwest end of the site may be a remnant of the wall shown.

The forge building (PRN 44445: Figs 4, 6, 8 and 9)

The best surviving building is the forge itself (plates 10 and 11). The building is constructed from random, squared blocks bonded with a grey mortar containing some charcoal and small stone inclusions. The best preserved section is the south wall, which survives to a height of 2.5m at its southwest corner. Overall the remaining structure measures 20m x 8m, but its original size is unknown. A short length of stone wall exposed in the side of the watercourse, 10m to the east may originally have been a part of it, although only excavation may reveal any relationship between them. There is a straight section of stone wall visible below the water level in the leat, which runs alongside the south wall, that may be the south side of a wheel pit (Fig. 6). A stone projection, which extends from the south wall of the forge slightly into the possible wheel pit, may have been part of the structure for supporting a wheel.

Internally, the building is divided into three rooms by the remains of two cross walls. Two of the rooms are of roughly equal size, *c.*4m x 4m, whilst the third and easternmost room is slightly larger, 6m x 4m. No internal fixtures or fittings were noted, but the vegetation cover on the walls and the amount of collapsed debris laying against the lower portions of the walls and covering the floors may be obscuring such detail. These factors make it difficult to be certain of the functions of each room, but a comparison with similar forges in other areas (Bowden 2001, 73-76) suggests that the central room may have contained the hearth, whilst the outer rooms contained the bellows and hammer. This interpretation requires the presence of two water wheels, one for each of the outer rooms, to power the bellows and hammer. There is no surface evidence for this, and only excavation could recover the evidence needed to be in any way certain of how the building functioned, a fundamental requirement for any understanding of the site.

A rectangular building, which appears to be the surviving forge structure, is shown in this location on both the 1789 plan and on both the 1st and 2nd edition Ordnance Survey maps of 1891 and 1907. On the 1789 plan, the surviving forge building is linked to the dam by a large square building, of which no definitely attributable remains are visible.

The other structures

The remnants of the walls of the west end of a stone-built structure (Fig. 8, No. 2), which was formerly built against the dam, just north of the blocked opening, were also recorded. The walls at the west end of the building are traceable as clearly defined stony banks, but the rest of the building seems to have been robbed. A building was shown in this position on the 1st and 2nd edition Ordnance Survey maps, but not on the 1789 plan.

A series of low banks (Fig. 8, No. 3), some with stone walling visible along the tops and in the sides, to the north of the previous structure, appear to form part of a building, or range of buildings. There is another low bank that may link this building to the northeast end of the dam. The 1789 plan shows a rectangular building in this position, which did extend from the northeast end of the dam. It also showed a small open, walled enclosure on the southeast end of the building and a surviving dog-

legged section of wall may be the corner of that enclosure. This range of buildings was not shown on the Ordnance Survey 1st edition map.

Even though it is not possible at present to be certain of the functions of this building, it is possible to speculate that it included charcoal and ore stores, a site office and possibly workers' accommodation.

Another series of low banks (Fig. 8, No. 4), one with exposed masonry, appear to define the remains of another building extending southwest from the northwest corner of the forge. The banks seem to represent the east, south and west walls of the possible building, with an internal cross wall dividing it into two rooms. No building is shown in this location on any of the maps of the site.

Other features

There are a number of mounds and hollows across the site, particularly along the northern edge of the site, which are of unknown origin, but may well relate to the demolition and collapse of the buildings and the subsequent removal of the reusable materials.

The repeated road widening that has occurred over the last 20 – 30 years has created a bank that forms a terrace along the northern side of the site. This has resulted in some of the remains of the northernmost buildings being buried and possibly protected.

Condition (Fig. 9)

The current condition of the both the Llandyfan sites is a major concern. They are heavily overgrown and the vegetation is causing structural damage, and in the case of the Old Forge the damage is severe.

At both sites trees are growing on the structures, which is destabilising them and it is doubtful if the masonry of the forge building on the Old Forge site can survive for much longer in its current state. Tree growth on the dam at the Old Forge is also having a serious affect (plate 12). This is particularly evident on the surviving wall facing on the southwest, or forge side, of the dam where wind blown trees have removed sections of the facing revealing the corework of the dam. Trees are also growing on the remains of buildings 2, 3 and 4, which are affecting the stability of the structures.

Understorey vegetation such as brambles are becoming widespread across much of the northern half of the site, which is beginning to obscure some of the remains in this area.

The Old Forge is also suffering increased waterlogging on the site, which is now regularly flooded. A pond has formed on the forge side of the dam, which is causing waterlogging across the centre of the site. The depth and extent of the waterlogging are at present unclear.

LLANDYFAN NEW FORGE

Location

The New Forge is situated on a flat terrace at the base of Carreg y Dwfan at SN65631682. It lies on the north side of the unclassified road that leads from Llandyfan to Trapp and which forms the southern edge of the forge site. The site was chosen with care to allow the creation of a large triangular pond to the north of the forge, which was used to power at least two waterwheels. Remains of two tailraces, which empty into the River Loughor, have been identified, to the south of the road.

History

A founding date for the New Forge of sometime during the later 1780s has been convincingly argued by Evans (1973, 146) using rentals and lease agreements. He also uses the important fact that some of the water supplied to the New Forge was supplied from the pond of the Old Forge, and clearly the amalgamation of the water supplies would have required either sole ownership or occupancy, or extremely good relations between the operators of the two forges. It is known that during the 1780s and most of 1790s William Roderick leased the land on which the New Forge was constructed whilst he continued production at the Old Forge.

A plan of the site dating from 1793 (Fig. 10) shows an L-shaped arrangement of two separate ranges of buildings with the large triangular pond to the north. The westernmost range is aligned roughly northwest-southeast and it includes a water wheel on the northwest end of the southwest wall. The detached northeast-southwest range is shown immediately below the dam for the pond and appears to consist of a row of buildings with open enclosures in front of them. This range probably included workers' housing and the site office.

The New Forge remained in Roderick's hands until its closure in 1808 due to his bankruptcy (Evans 1973, 147). It may be no coincidence that Roderick's bankruptcy occurred at about the same time as the Old Forge was closed due to severe flooding undermining its buildings. The link between the water supplies may have resulted in the New Forge being at least partially cut off when the Old Forge was flooded, or slightly later in the aftermath of the flood, when the Old Forge was closed and the site no longer maintained. Another possibility is that the forge was a victim of Roderick's bankruptcy and it could have been one of his other industrial enterprises that failed. Whatever the cause the forge and the surrounding land was put up for auction in Llandeilo on 3rd September 1808 (Evans 1973, 147).

Following the auction, the forge was sold to Peter DuBuisson of Glynhir for £70, who was supposedly acting on behalf of Lord Dynevor. In reality DuBuisson does not appear to have transferred the property to Lord Dynevor and it is possible that he resumed production at the forge to supply iron to his knife works at nearby Glynhir. There is no proof of this, but the Glynhir knife works are supposed to have continued in production until the end of the Napoleonic Wars in 1815 (Evans 1973, 147) and it seems reasonable to assume that DuBuisson would have wanted to maintain the easily accessible supply of local iron.

Whatever the truth of the situation following Roderick's bankruptcy in 1808, the works had closed by the 1830s and from the early 1840s the forge had been converted into a woollen mill, which operated into the 20th century.

The site (Fig 10, 12 and 13)

There are substantial remains of the woollen mill buildings, which in places survive up to *c*.6m high. The pond and the buildings are becoming overgrown and there is a vast amount of rubble in the buildings' interiors, obscuring the floors and any internal detail. Fallen masonry has partially blocked the leat along the western side of the buildings, although water from the pond is still finding its way out through the leat and into the River Loughor.

The pond (PRN 44447) **and its water supply**

The pond occupies a triangular area to the north of the buildings. It was formed by constructing a large earth dam against the base of the slope of Carreg-y-Dwfan. The south bank had been faced with a stone wall, which also formed the north, rear, wall of the northeast-southwest range of buildings. Water to fill the pond was supplied by two leats, one that fed directly from the River Loughor, somewhere in the vicinity of Llandyfan Bridge and the other linked to the pond at the Old Forge (Figs 12 and 13). The leats fed into the northeast corner of the pond and a stone structure, *c*.20m east of the forge buildings may have been part of the original sluice. Road widening over the last 20 – 30 years has filled in the leats.

A length of stone revetment along part of the southern bank of the pond may have been inserted to block an old leat leading to a second and disused wheel pit (see below).

The wheel pit and tailrace (PRN 44448: Figs 10 and 13)

The waterwheel for the forge was fed from the southwest corner of the pond via a narrow channel and presumably a wooden launder, which has not survived. A sluice originally controlled the flow of water from the pond into the channel, and the stone structure of the sluice survives, but the timber sluice gates were either removed, or they have rotted away. A stone revetment of the face of the dam forms the back of the wheel pit, which was positioned at the northern end of the southwest wall of the forge (Plate 13). A straight-faced section of wall, which survives at ground level on the southwest side of the assumed wheel pit, gives a wheel pit/tailrace width of 1.75m. The wheel was of the overshot type.

Fallen masonry and erosion has reduced the width of the tailrace as it runs alongside the forge. At one point it disappears underground and reappears 2-3m to the south, some 1m lower than its original height. From here it passes under the road and empties into the River Loughor. The drop in height is difficult to explain without excavation, but it may be that at the point at which it disappears may be the end of a wheel pit and the water is finding its own way out through the side of the pit.

The blocked wheel pit and tailrace (PRN 444450: Fig 13)

A break in the north wall, 15m from the southwest end, had apparently been blocked by the dumping of large flat stone slabs and rubble. Below the break, in the interior of the building, was a narrow channel formed by the northeast wall of room 2 and the southwest wall of room 3 (plate 14). The channel measured 8m long x 1.5m wide. There is a muddy depression leading from the southern edge of the pond towards the break in the wall and even though no direct relationship between them was established it is clear that the depression was the infilled remains of a leat leading to a waterwheel that stood in the channel below the break in the wall. An irregular and partially overgrown linear hollow identified in the bank on the opposite side of the road may be the end of the tailrace.

There is little doubt that this group of features represent the remains of a second wheel pit and its water supply, but, it is not clear which phase of the site's use it was associated with. Clearly it was not its final, early 20th century phase and according to the 1793 plan not its earliest, late 18th century phase. The most likely explanation is that it was a short-lived adaptation dating from the conversion of the forge into a woollen mill in the early 1840s. However, this remains conjectural and only investigation of the site itself will resolve this intriguing question.

The buildings (Figs 10 and 13)

The 1793 plan of the site shows the forge building to be aligned roughly northeast-southwest and the remains of a building survive in this location survive today. It is difficult to be certain how much of the fabric visible today is from the forge and how much dates from the later woollen mill. It is unlikely that the forge buildings were completely demolished prior to the construction of the woollen mill, so some, perhaps a substantial proportion, of the fabric may belong to the original forge buildings. Furthermore, understanding its exact layout is difficult because of the amount of collapsed masonry and the vegetation cover, which is obscuring the interior of the southern half of the building.

The northwestern end of the building is the most complete, where the southwest wall survives to a height of *c.*6m and the north wall stands to a height of *c.*4m. Only the northernmost room (room 1), *c.*5m x 5m internally, was identifiable. A ledge along the northwest wall and a short surviving length of the northeast wall that was built to the same height as the ledge, *c.*2.5m above the current ground level, appear to be at floor joist height for an upper room. No internal fixtures or fittings were visible in the room, so it was not possible to determine the function or internal layout of the room.

A large opening with a flattened stone arch in the southwest wall (plate 13) may have been a loading door for the upper room of the woollen mill, although it is located above the waterwheel. There was a blocked arched, or round opening towards the base of the wall, which may have been for the gear leading from the waterwheel; the bottom of the opening was obscured by fallen masonry. Other openings in the west wall, some of which had been blocked either partially or completely, probably date from the alteration of the buildings from forge to woollen mill.

The lack of surviving structure for the southern half of the building (room 6) suggests that the focus of the operations were at the northern end building and it may signify a shift in the direction of the industrial processes carried out on the site. On the 1793 plan of the site the forge and, therefore, its processes were clearly aligned northwest-southeast and the forge was separated from the other building on the site. But it seems that when the site was converted to a woollen mill the buildings may have been linked and the processes of the woollen mill possibly concentrated more along the northeast-southwest aligned buildings, through rooms 1-4 and possibly later into room 5.

Room 5 was a later addition to the northeast end of the building and it had to be constructed on a different alignment because of the existing line of the road. It has been reported that there used to be a chimney, no longer visible, on the north wall of room 5[10]. Without excavation it is not possible to determine the function of room 5, or to assign it to a particular phase of the site's use, but it is clearly a later addition.

Other features

A small number of features, which appeared to be associated with site, were recorded between the road and the River Loughor. They consisted of a low vegetation covered linear bank that included some apparently *in situ* stone wall and one linear and two small sub-circular hollows.

The linear bank measured 10m x 8m and it formed a narrow, open-ended hollow. This feature, of unknown function, appears in almost its current state on the Ordnance Survey map of 1906. The linear hollow runs parallel to the northeast side of the possible building and the two may be associated. The two small sub-circular hollows may be shallow ore-pits, as indeed, might the linear hollow.

Condition (Fig. 14)

Large trees are growing on the dam, close to the blocked wheel pit and on many of the walls of the surviving structure. There are also many established trees growing on the rubble inside the buildings. The sides of the pond, particularly the bank on the west side, are very overgrown. Vegetation and soil development are beginning to obscure some parts of the buildings and all of the rooms within the buildings are rubble filled. The extensive layers of rubble that currently fill are protecting any low-level internal fixtures or fittings from further damage.

Room 1 has standing water, presumably leaking in from the wheel pit and tailrace on the outside of the southwest wall, which will eventually lead to stability problems with the walls (Plate 16).

[10] Information from the Cadw site visit forms (visit made in 1986).

APPENDIX ONE: GAZETTEER OF SITES

One of the important aspects of this project has been to update the information held on the Sites and Monuments Record for those sites already recorded, and to record new sites and, where identifiable, the individual components that made up the sites.

The following gazetteer includes the sites identified during this study (see Fig. 1 for the location of each site), and the individual site components.

PRN 83
SN42082063
CARMARTHEN FURNACE
BLAST FURNACE
LISTED BUILDING 2

PRN 3608
SN06561449
BLACKPOOL BRIDGE
BLAST FURNACE
SAM Pembs. 484
includes

PRN	TYPE
44451	LEAT
44452	WHEEL PIT

PRN 4491
SN50390151
OLD FURNACE;RABY'S FURNACE
FURNACE
SAM Carms 219

PRN 5376
SN41002546
CWMDWYFRAN
FORGE
LISTED BUILDING 2

PRN 8876
SN656168
THE FORGE;LLANDYFAN FORGE
FORGE
SAM Carms.223
includes
PRN 44441
PRN 44446

PRN 8956
SN208181
WHITLAND ABBEY
FORGE

PRN 9928
SN47410917
PONT HENRY
FURNACE
SAM Carms. 227

PRN 24186
SN061143
BLACKPOOL FORGE
FORGE

PRN 30134
SN06891391
UNKNOWN
CHARCOAL BURNING PLATFORM

PRN 30668
SN4005
KIDWELLY FORGE
IRON FOUNDRY

PRN 30669
SN35432570
CWMBRAN FORGE
IRON FOUNDRY

PRN 30707
SN478085
FFWRNEIS PONTIETS
IRON FOUNDRY

PRN 44441
SN65901694
LLANDYFAN OLD FORGE
FORGE
SAM Carms. 223
includes

PRN	TYPE
44442	POND
44443	DAM
44444	LEAT
44445	FORGE

PRN 44446
SN65631682
LLANDYFAN NEW FORGE
FORGE
SAM Carms 223
includes

PRN	TYPE
44447	POND
44448	LEAT
44449	WHEEL PIT
44450	WHEEL PIT

REFERENCES

Anon 1937 *The Transactions of the Carmarthenshire Antiquarian Society and Field Club*, Volume **XXVII** parts LXII-LXIV, page 11.

Crossley D 1975a *Sidney ironworks Accounts 1541-1573*. Royal Historical Society. London

Crossley D 1975b *The Bewl Valley Ironworks, Kent, c.1300-1730*. The Royal Archaeological Society Monograph. London.

Crossley D 1981 Medieval iron smelting. In Crossley D (ed), 1981.

Crossley D (ed) 1981 *Medieval Industry*. Research Report No 40. Council for British Archaeology. London.

Devonshire A & Wood B 1996 *Women in Industry and Technology from Prehistory to the Present Day: Current Research and the Museum Experience*. Museum of London. London.

Dinn J 1988 Dyfi Furnace excavations 1982-87. *Post-medieval Archaeology* Volume **22**, p111-142.

English Heritage 2001 *Centre for Archaeology Guidelines: Metallurgy*. English Heritage. London.

Evans M C 1967 The pioneers of the Carmarthenshire Iron Industry. *The Carmarthenshire Historian*, **4** 22-40.

Evans M C 1973 *The Llandyfan Forges: a study of ironmaking in the Upper Loughor Valley*. The Carmarthenshire Antiquary. Volume IX, 131-156.

Evans M C 1975 *Cwmdwyfran Forge 1697-1839*. The Carmarthenshire Antiquary. Volume XI, 146-176.

Eyre Evans G 1917 *The Transactions of the Carmarthenshire Antiquarian Society and Field Club*, Volume **XI** parts XXIX-XXX.

Geddes J 1996 *Medieval Women in the Heavy Metal Industries*. In Devonshire A and Wood B (eds) 1996, 101-109.

Hammersley G 1973 The Charcoal Iron Industry and its fuel, 1540-1750. *Economic History Review*, **26**, p593-613.

Hoover H & Hoover L 1950 *Georgius Agricola: De Re Metallica*. Translated from the first Latin edition of 1556. Dover Publications, Inc. New York.

Howell D W 1986 *Patriarchs and Parasites: The Gentry of South-West Wales in the Eighteenth Century.* University of Wales Press. Cardiff.

Howell D W 1987 'The Economy, 1660-1793'. In Howells (ed) 1987, 299-332.

Howells B (ed) 1987 *Pembrokeshire County History Volume III: early modern Pembrokeshire, 1536-1815.* Pembrokeshire Historical Society. Haverfordwest.

James H 1992 *Past Land-use at Carmel Woods, Near Llandybie, Dyfed.* Unpublished Dyfed Archaeological Trust report. Llandeilo.

James T 1976 Carmarthen Tinplate Works 1800-1821. *The Carmarthenshire Antiquary* Vol.**XII**, p31–54.

Jenkins J G 1976 *Life and tradition in rural Wales.* J M Dent & Sons Ltd. London.

Lindsay J M 1975 Charcoal iron smelting and its fuel supply: the example from Lorn Furnace, Argyllshire 1753-1876. *Journal of Historical Geography 1*, **3**, p283-298).

Linnard W 1982 *Welsh woods and forests, history and utilization.* National Museum of Wales. Cardiff.

Marren P 1990 *Woodland Heritage: Britain's Ancient Woodland.* David & Charles. Newton Abbot.

Murphy K & Ludlow N 2002 *Historic landscape Characterisation of the Milford Haven Waterway on the Register of Landscapes of Outstanding Historical Interest in Wales.* Unpublished Cambria Archaeology Report for Cadw: Welsh Historic Monuments. Report No.2002/02.

Newman R Cranstone D & Howard-Davis C 2001 *The Historical Archaeology of Britain, c.1540-1900.* Sutton Publishing. Stroud, Gloucestershire.

Rackham O 1994 *The Illustrated History of the Countryside.* BCA. London

Rees W 1953 *A Survey of the Duchy of Lancaster Lordships in Wales 1609-1613.* University of Wales Press. Cardiff.

Rees W 1968 *Industry before the industrial revolution Volume I.* University of Wales Press. Cardiff.

Riden P 1987 *A Gazetteer of Charcoal-fired blast furnaces in Great Britain in use since 1660.* Phillip Riden. Cardiff.

Roberts C 1983 *A legacy from Victorian Enterprise: the Briton Ferry Ironworks and the daughter companies*. Sutton Publishing. Stroud, Gloucestershire.

Schubert H R 1957 *History of the British iron and steel industry 450BC-AD1775*.

Thorne R & Howells R 1987 'Pembrokeshire in Wartime, 1793-1815'. In Howells (ed) 1987, 360- 403.

THE CHARCOAL-FUELLED IRONWORKING INDUSTRIES OF CARMARTHENSHIRE AND PEMBROKESHIRE

VOLUME 2: ILLUSTRATIONS AND PHOTOGRAPHS

Report No. 2002/26

Report Prepared for:
CADW: WELSH HISTORIC MONUMENTS

CAMBRIA ARCHAEOLOGY

REPORT NO. 2002/26
PROJECT RECORD NO. 44754

CHARCOAL-FUELLED IRONWORKING INDUSTRIES OF CARMARTHESNHIRE AND PEMBROKESHIRE
VOLUME 2: ILLUSTRATIONS AND PHOTOGRAPHS

March 2002

By

Nigel Page & Hubert Wilson

ARCHAEOLEG CAMBRIA
Ymddiriedolaeth Archaeolegol Dyfed Cyf
Neuadd y Sir, Stryd Caerfyrddin, Llandeilo, Sir Gaerfyrddin SA19 6AF
Ffon: Ymholiadau Cyffredinol 01558 823121
Adran Rheoli Treftadaeth 01558 823131
Ffacs: 01558 823133
Ebost: cambria@acadat.com Gwefan: www.acadat.com

CAMBRIA ARCHAEOLOGY
Dyfed Archaeological Trust Limited
The Shire Hall, Carmarthen Street, Llandeilo, Carmarthenshire SA19 6AF
Tel: General Enquiries 01558 823121
Heritage Management Section 01558 823131
Fax: 01558 823133
Email: cambria@acadat.com Website: www.acadat.com

The Trust is both a Limited Company (No. 1198990) and a Registered Charity (No. 504616)
CADEIRYDD *CHAIRMAN: B.C.BURNHAM, MA PHD FSA MIFA.* CYFARWYDDWR *DIRECTOR: E G HUGHES BA MIFA*

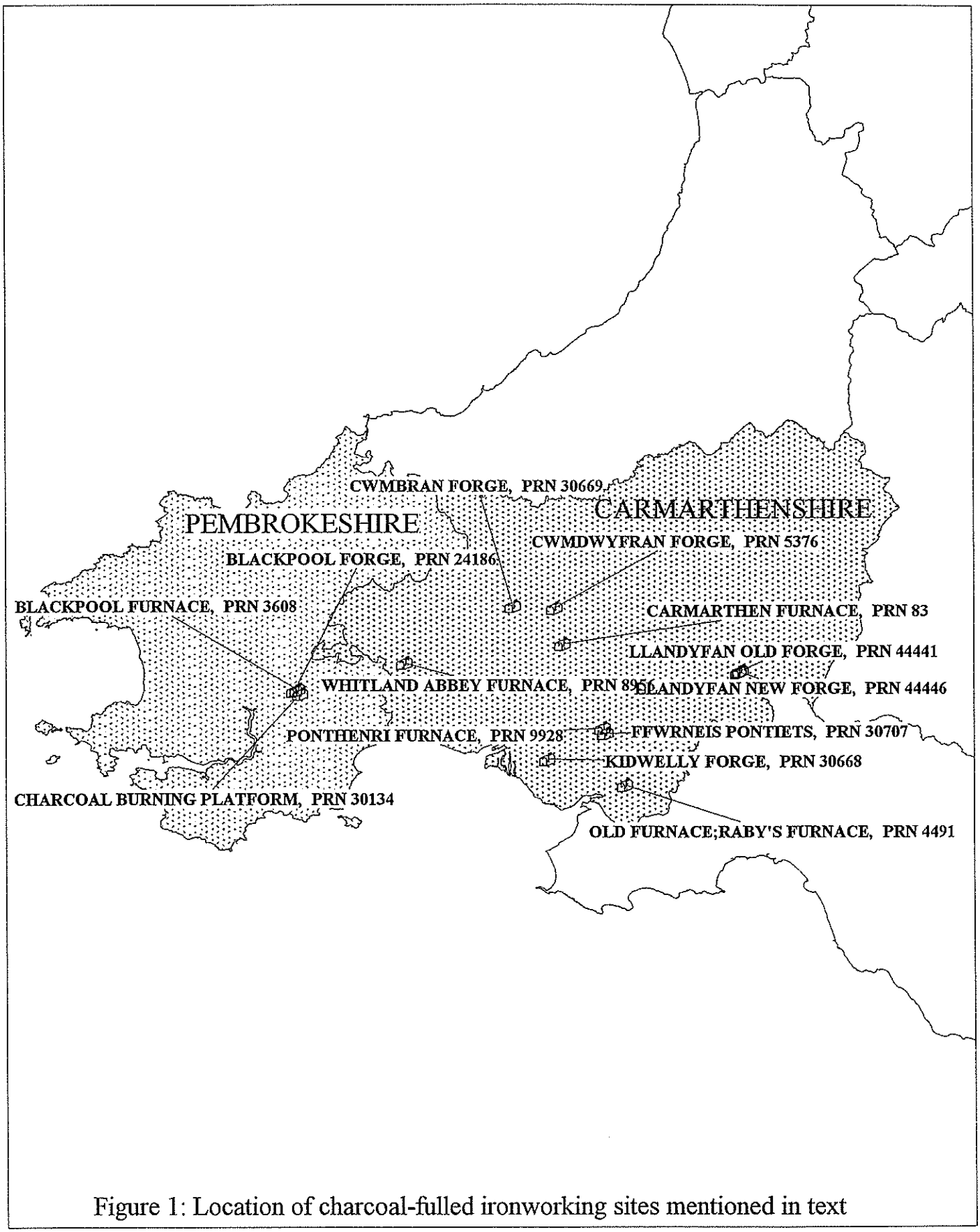


Figure 1: Location of charcoal-fulled ironworking sites mentioned in text

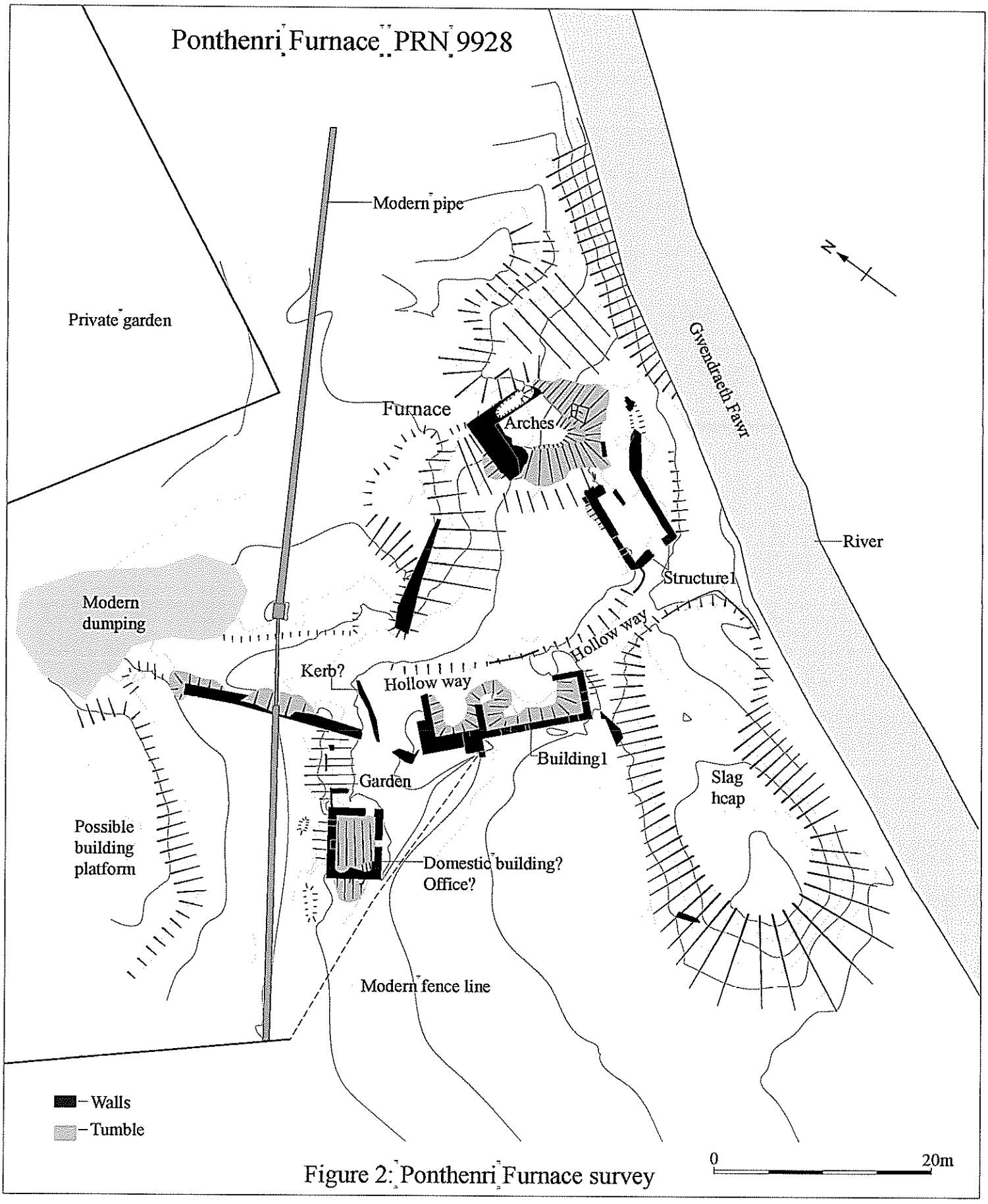


Figure 2: Ponthenri Furnace survey

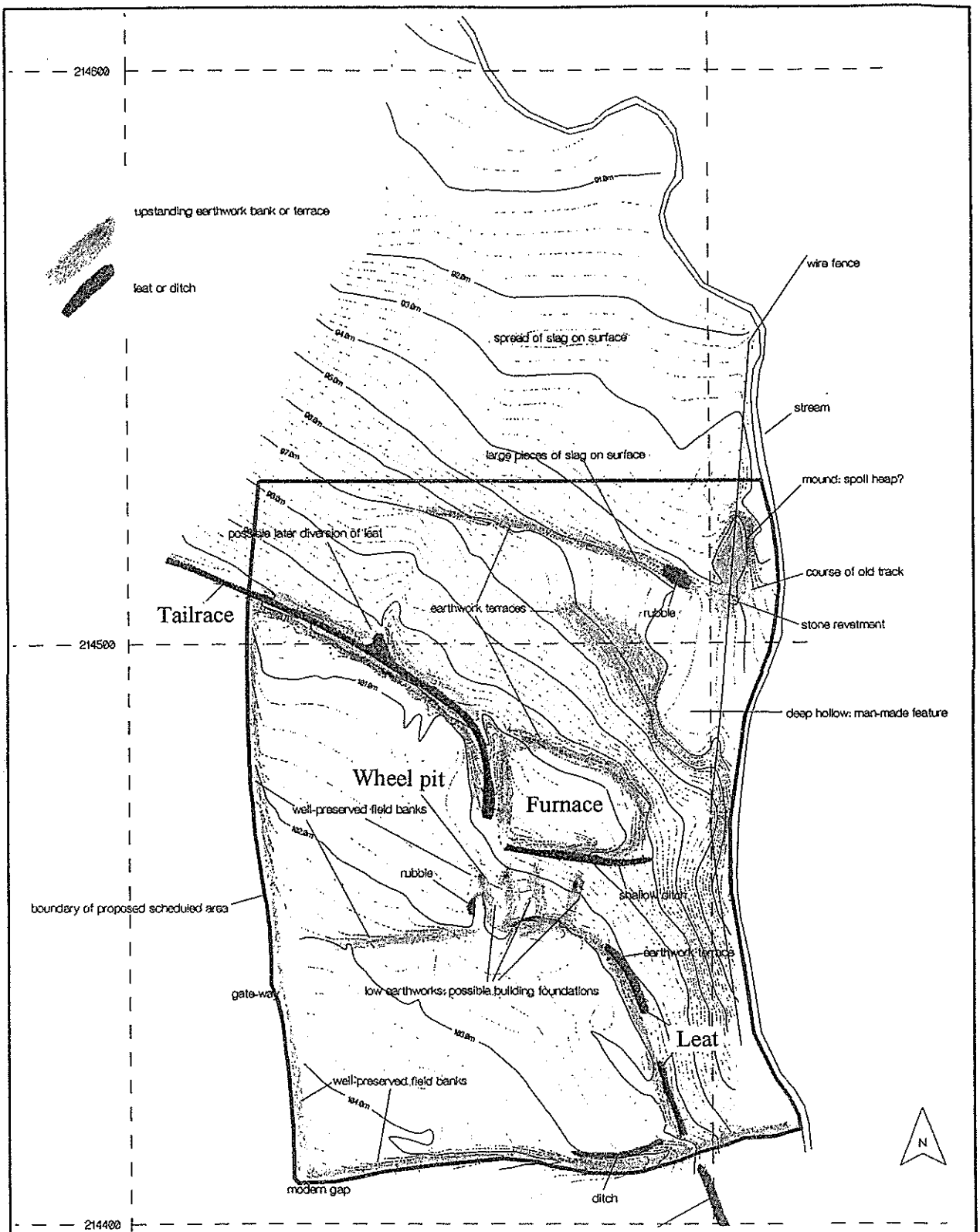
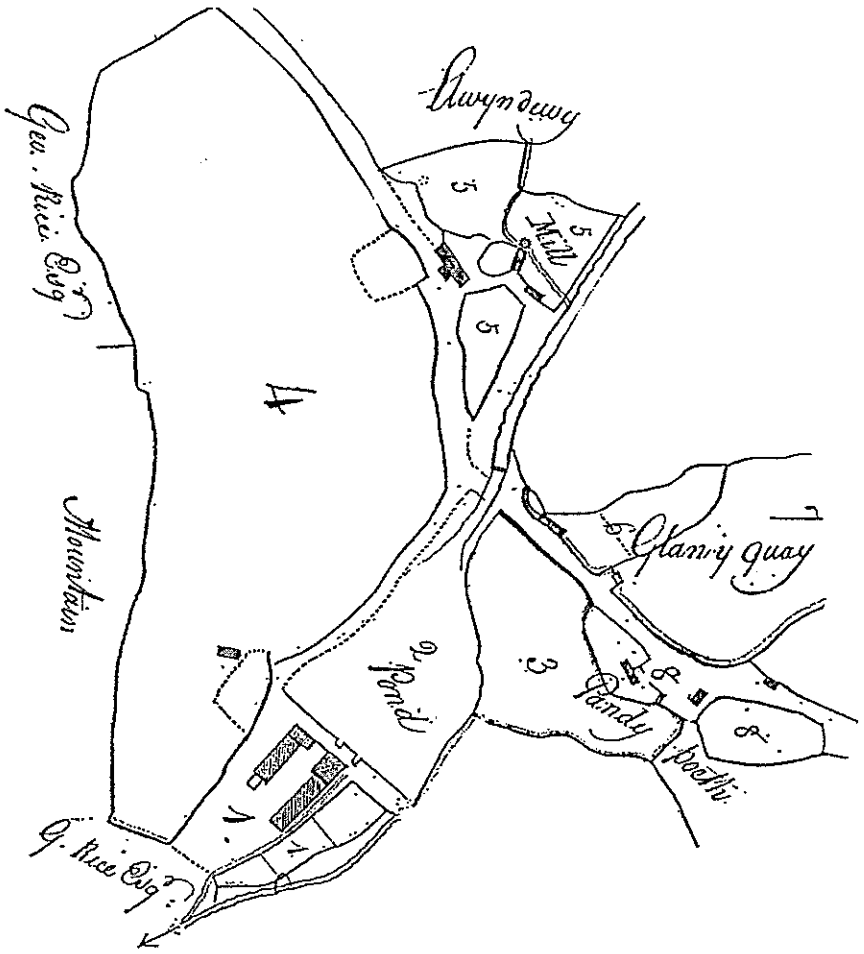


Figure 3: 1996 Canaston Wood survey. (After Murphy and Trethowan 1996).



1. Forge buildings ; 2. The Pond ; 3. Cae bach ;
4. Yr Erw ; 5. Forge Mill (corn) ; 6 & 7. Glan y quay ;
8. Pandy poeth, houses and garden.

Figure 4: Llandyfan Old Forge in 1789. The original was drawn with north in the wrong direction. Note the presence of the dam, the forge building and outbuildings.

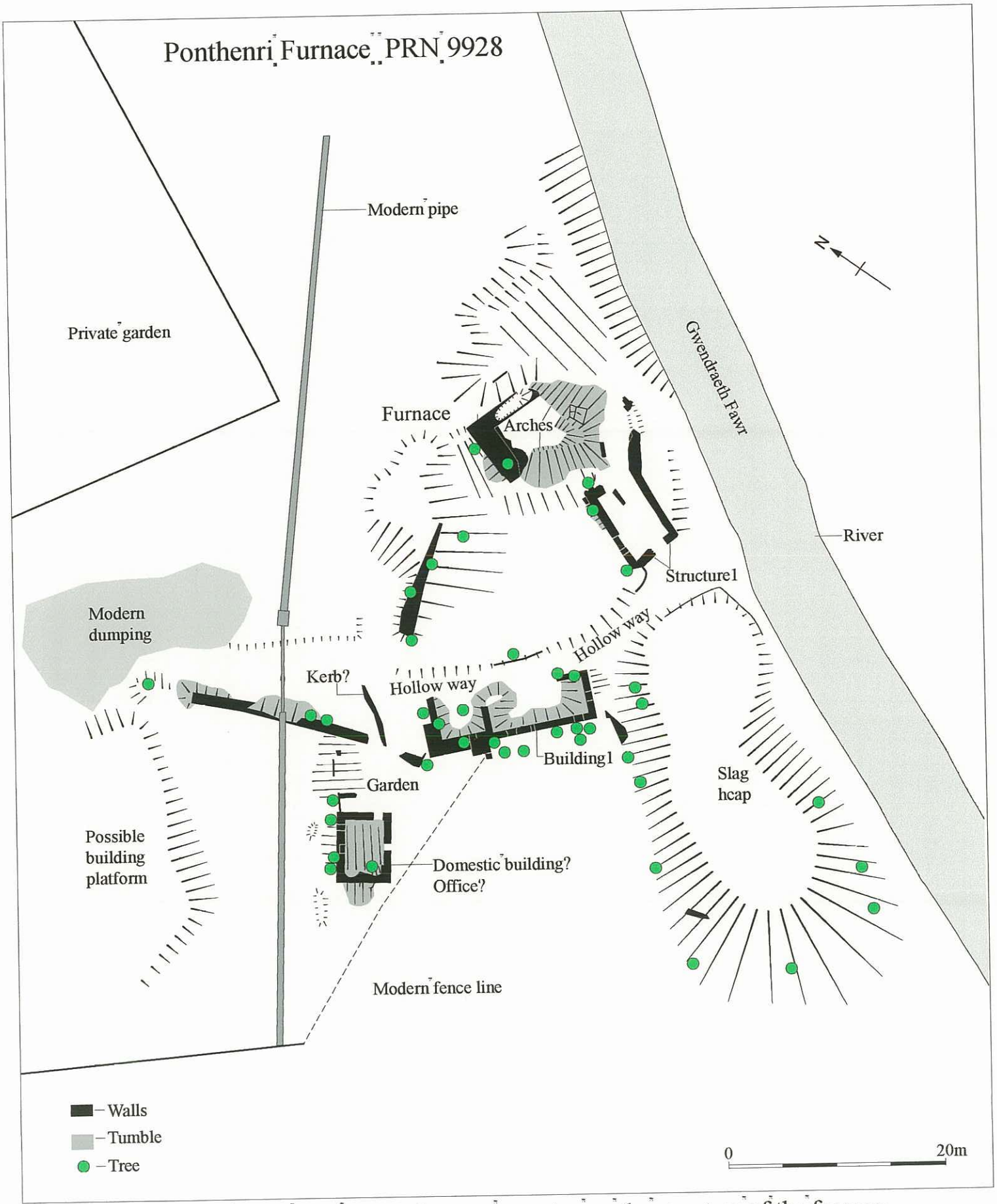


Figure 5: Trees over 60cm diameter growing on the structure of the furnace

Figure 6: Llandyfan Old Forge showing the pond

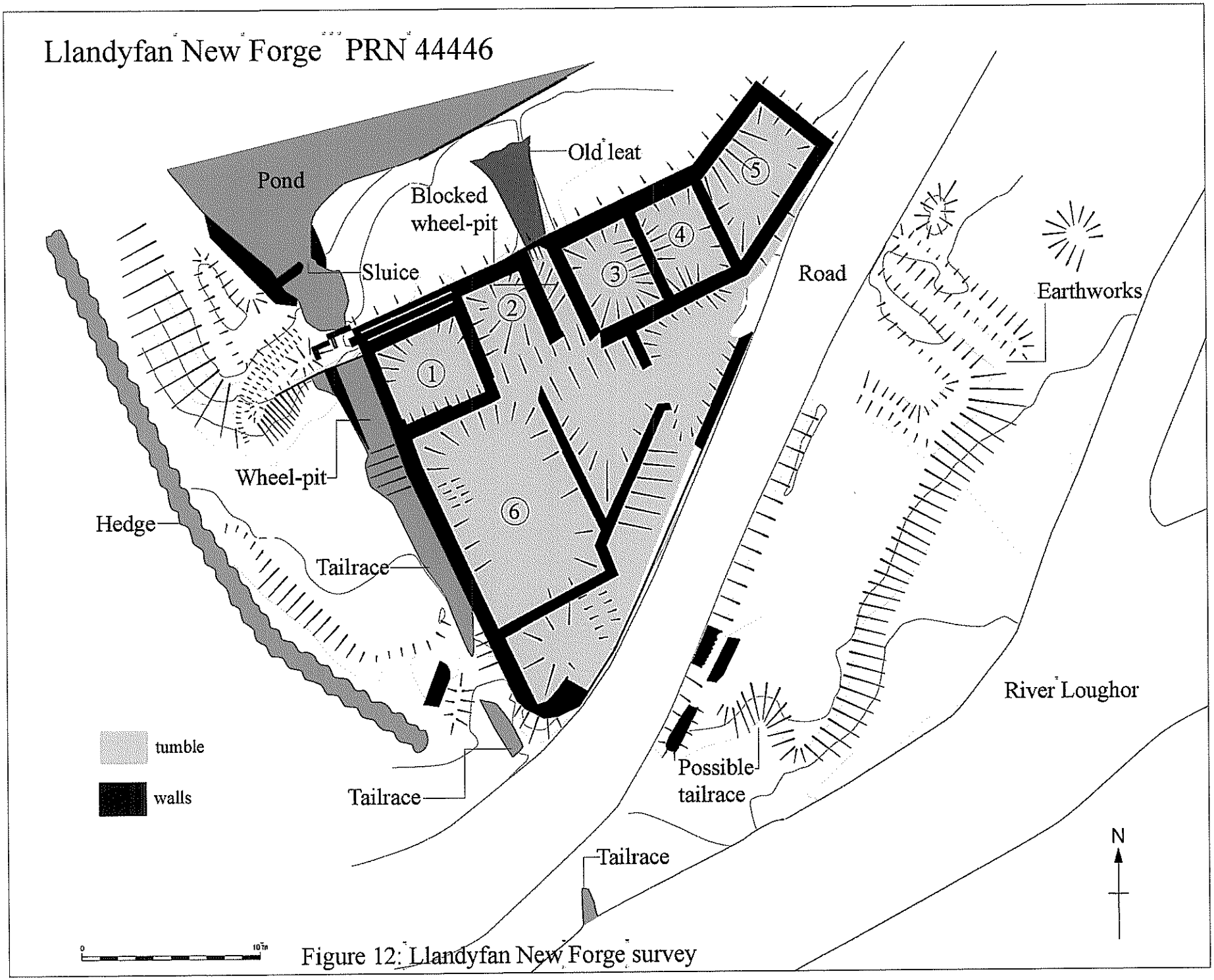


Figure 12: Llandyfan New Forge survey

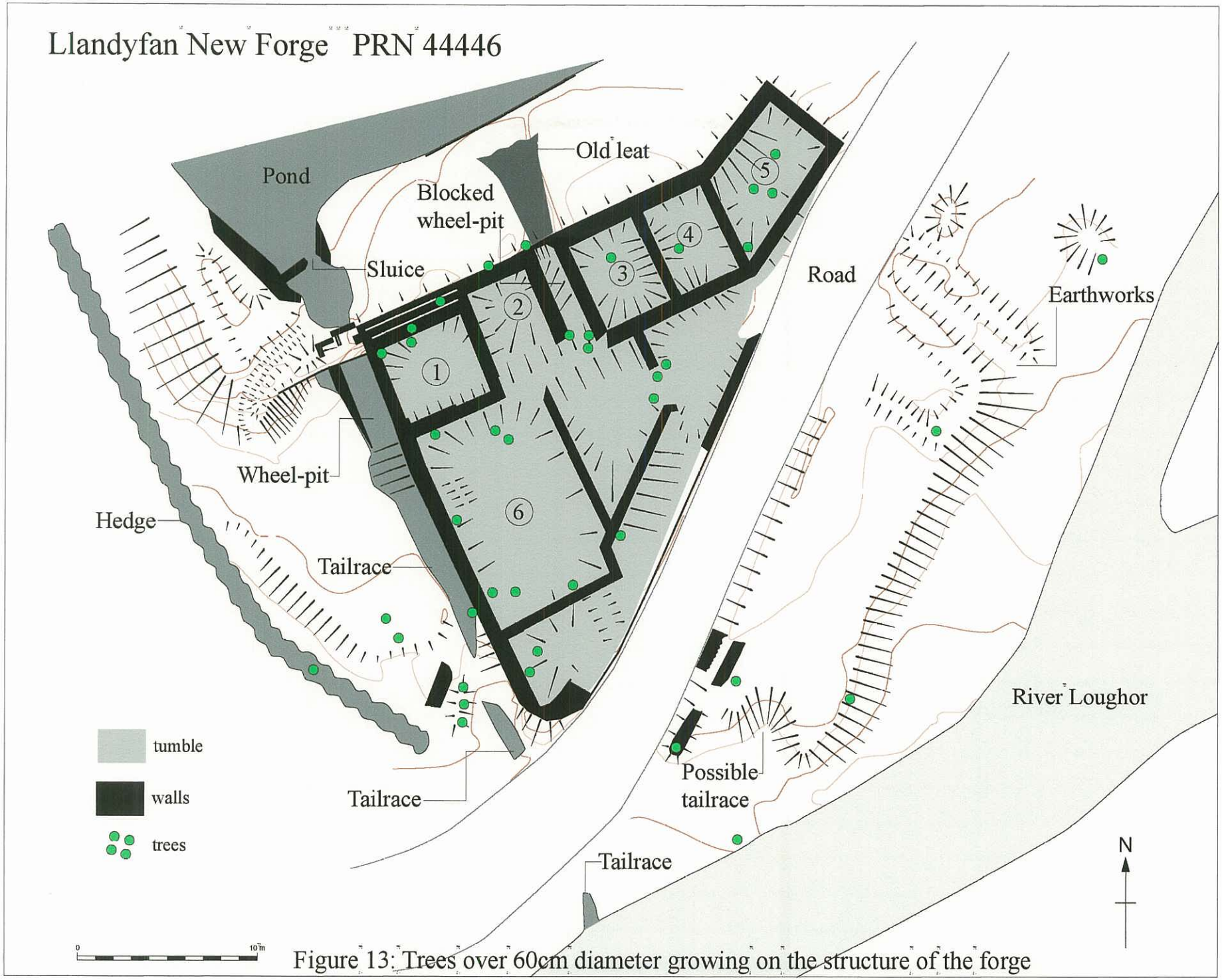


Figure 13: Trees over 60cm diameter growing on the structure of the forge

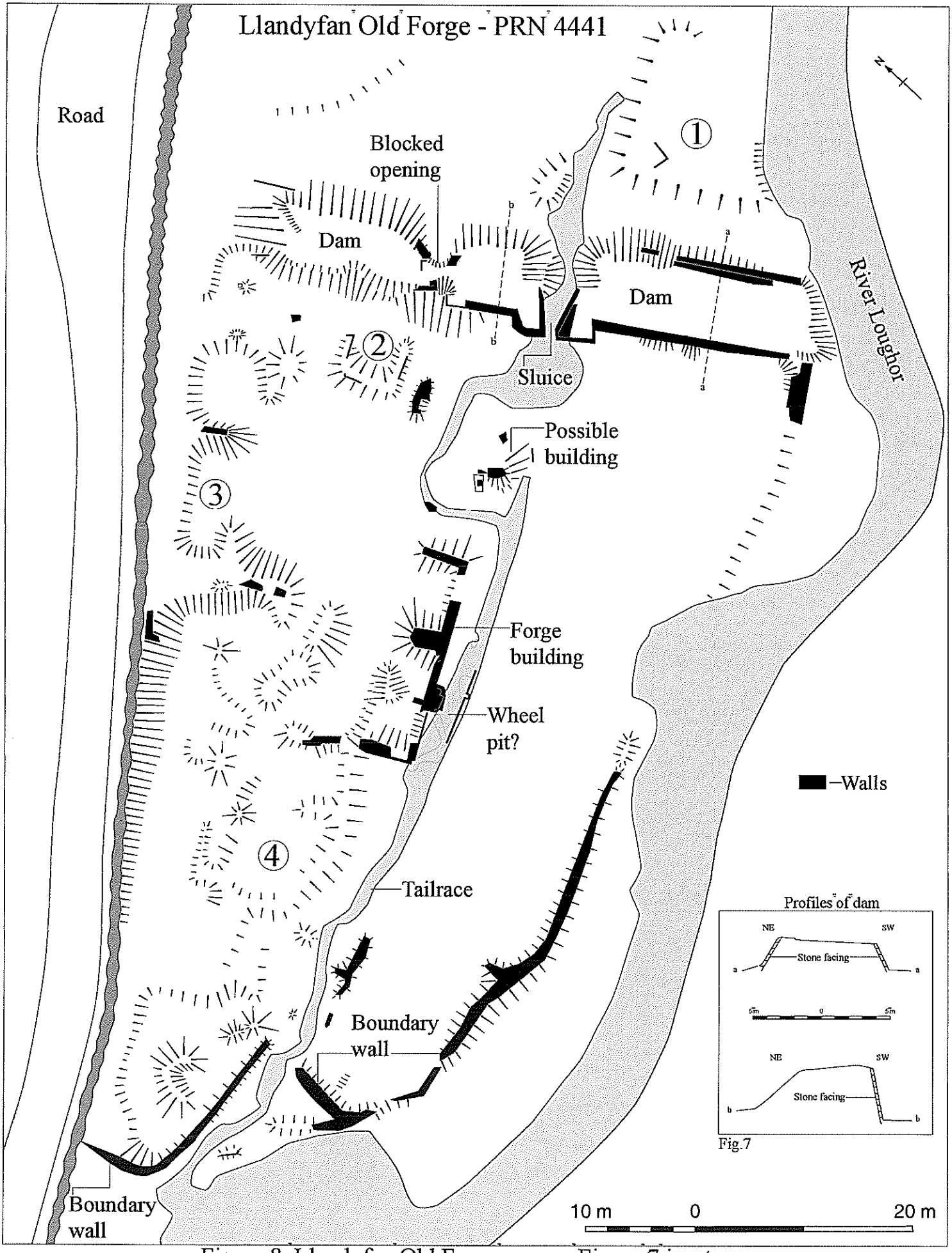


Fig.7

Figure 8: Llandyfan Old Forge survey. Figure 7 inset.

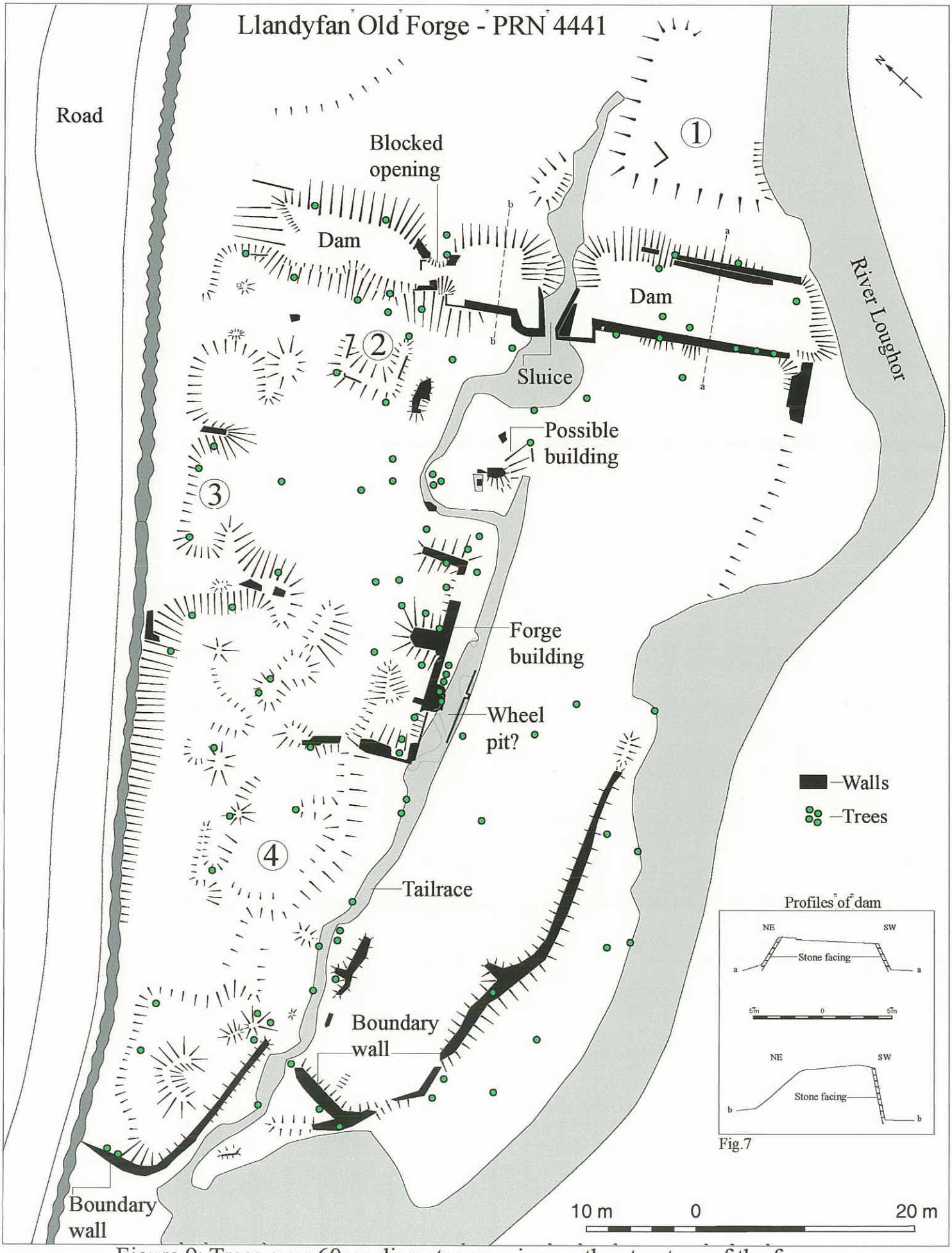


Fig.7

Figure 9: Trees over 60cm diameter growing on the structure of the forge

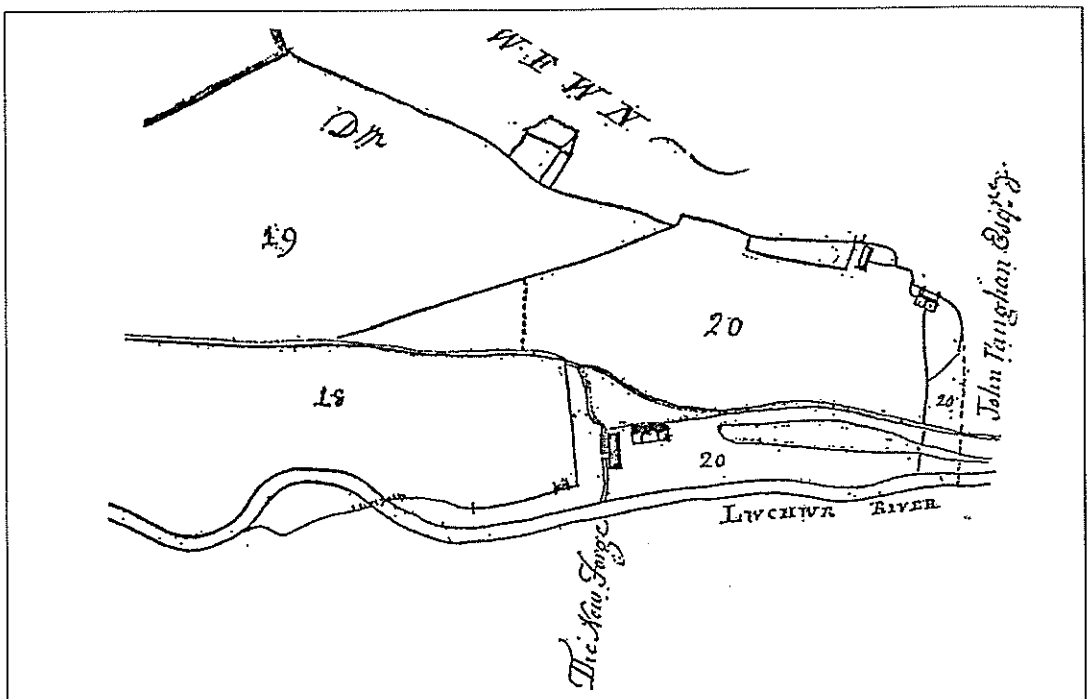


Figure 10: 1793 plan of Llandyfan New Forge. (After Evans 1973).

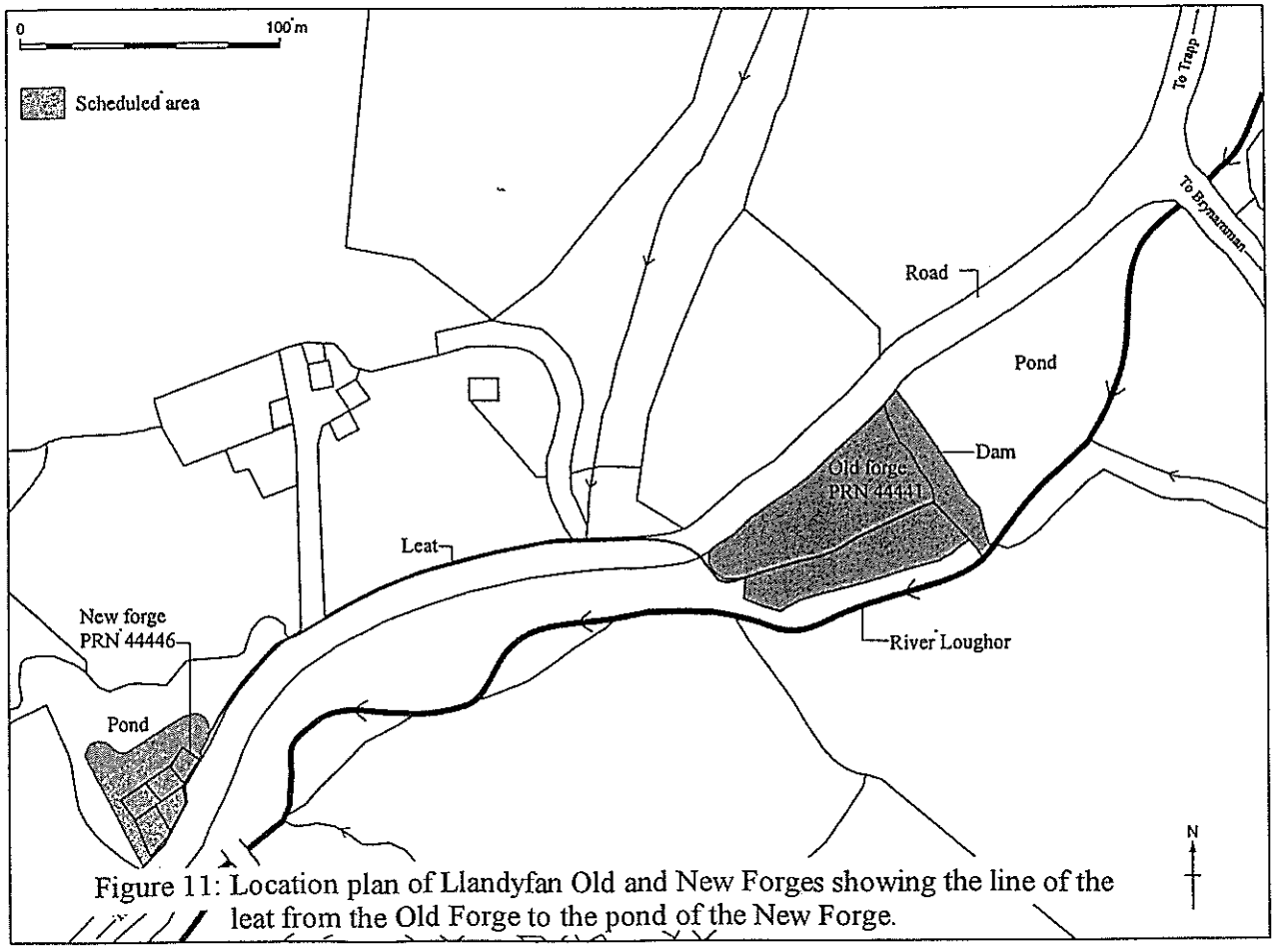


Figure 11: Location plan of Llandyfan Old and New Forges showing the line of the leat from the Old Forge to the pond of the New Forge.

Plate 1: Ponthenri Furnace (PRN 9928). View northeast of the furnace structure showing the recent collapse.

Plate 2: Llandyfan Old Forge (PRN 44441). The sluice exit in the dam. Note the ponding in front of the dam, which is leading to increased waterlogging of the central section of the site.

Plate 3: Blackpool Furnace (PRN 3608). A general view northeast across the site showing the regenerating vegetation and the self-seeding trees. None of the features recorded in the 1996 survey are visible.

Plate 4: Ponthenri Furnace (PRN 9928). The collapsed arches of the furnace structure.

Plate 5: Ponthenri Furnace (PRN 9928). The northeast gable of the domestic building, showing the low timber framed door and gable window.

Plate 6: Ponthenri Furnace (PRN 9928). Surviving masonry of the southwest corner of Structure 1

Plate 7: Ponthenri Furnace (PRN 9928). View of northwest corner of the furnace structure with large tree growing on top.

Plate 8: Ponthenri Furnace (PRN 9928). The stormy weather encountered during the survey resulted in 1m of the southwest gable being lost. The damaged area is to the left of the tree growing inside the building.

Plate 9: Llandyfan Old Forge (PRN 44441). The blocked opening in the dam. The function of this feature remains unclear. It may be a blocked sluice, but only excavation could elucidate this further.

Plate 10: Llandyfan Old Forge (PRN 44441). Remains of the forge building. The trees centre left are growing on what may be the remains of the structure for a water wheel.

Plate 11: Llandyfan Old Forge (PRN 44441). The surviving masonry of the southwest corner of the forge building.

Figure 12: Llandyfan Old Forge (PRN 44441). Trees growing on the dam.

Plate 13: Llandyfan New Forge (PRN 44446). The top of the blocked wheelpit is visible behind the scale.

Plate 14: Llandyfan New Forge (PRN 44446). View across the wheelpit area towards the southwest gable wall. The water fed an overshot wheel from a launder that was originally in the area now occupied by the large tree to the left of the wall.

Figure 15: Llandyfan New Forge (PRN 44446). Interior shot of southwest gable wall of Room 1.

Figure 16: Llandyfan New Forge (PRN 44446). Standing water in Room 1. This picture also shows the tree and vegetation cover across the site, including some recent windblown trees that have fallen on the structure.

THE CHARCOAL-FUELLED IRONWORKING INDUSTRIES OF CARMARTHENSHIRE AND PEMBROKESHIRE

VOLUME 3: RECOMMENDATIONS

Report No. 2002/26

Report Prepared for:
CADW: WELSH HISTORIC MONUMENTS

CAMBRIA ARCHAEOLOGY

REPORT NO. 2002/26
PROJECT RECORD NO. 44754

CHARCOAL-FUELLED IRONWORKING INDUSTRIES OF CARMARTHESNHIRE AND PEMBROKESHIRE
VOLUME 3: RECOMMENDATIONS

March 2002

By

Nigel Page & Hubert Wilson

ARCHAEOLEG CAMBRIA
Ymddiriedolaeth Archaeolegol Dyfed Cyf
Neuadd y Sir, Stryd Caerfyrddin, Llandeilo, Sir Gaerfyrddin SA19 6AF
Ffon: Ymholiadau Cyffredinol 01558 823121
Adran Rheoli Treftadaeth 01558 823131
Ffacs: 01558 823133
Ebost: cambria@acadat.com Gwefan: www.acadat.com

CAMBRIA ARCHAEOLOGY
Dyfed Archaeological Trust Limited
The Shire Hall, Carmarthen Street, Llandeilo, Carmarthenshire SA19 6AF
Tel: General Enquiries 01558 823121
Heritage Management Section 01558 823131
Fax: 01558 823133
Email: cambria@acadat.com Website: www.acadat.com

The Trust is both a Limited Company (No. 1198990) and a Registered Charity (No. 504616)
CADEIRYDD *CHAIRMAN: B.C.BURNHAM, MA PHD FSA MIFA.* CYFARWYDDWR *DIRECTOR: E G HUGHES BA MIFA*

THE EARLY POST-MEDIEVAL CHARCOAL-FUELLED IRONWORKING INDUSTRIES OF CARMARTHENSHIRE AND PEMBROKESHIRE

RECOMMENDATIONS FOR FURTHER INVESTIGATION AND LONG-TERM MANAGEMENT

INTRODUCTION

This study has shown that there are serious problems facing the surviving sites. The earliest and best-preserved sites are scheduled ancient monuments, but the scheduling is not in these cases offering them the best protection. Therefore one of the aims of this project has been to make recommendations that may offer better long-term protection for these important sites and the information they contain. The following recommendations have been ordered by site.

BLACKPOOL FURNACE (PRN 3608)

George Mynne's furnace, the site of which now lies in the Forest Enterprise owned Canaston Wood, is a Scheduled Ancient Monument, and it remains the only known blast furnace in Pembrokeshire from this crucial period in the development of the Welsh Ironworking industry. There are a number of recommendations for this site, which include immediate remedial works as well as proposals that will aid the longer-term survival of the site. The extent, nature and condition of the buried remains of the furnace are unknown. Likewise, the effect of the former forestry operations, and the current regeneration on the site is unknown.

Remedial works

The regenerating trees and scrub vegetation should be removed from the site. Once the site has been cleared, the condition of the site should be reassessed using the 1996 survey results.

Some form of evaluation is required to fully assess the survival and potential of the site, followed by a sustainable programme of land management and monitoring to promote its long-term protection. This can perhaps be achieved by making the site an area of open grassland, perhaps a picnic site, which once established could be maintained through regular grass cutting. Under this sort of regime, the surviving earthworks would be visible allowing better protection and long-term monitoring.

Some form of interpretation should enhance visitor enjoyment of the site. An evaluation, targeted at key areas of the site should provide information that can aid the interpretation and understanding of the working of the furnace as well as feeding into the overall management strategy for the site.

PONTHENRI FURNACE (PRN 9928)

The survey has highlighted a number of areas of concern for the future long term management of this very important site. This is the earliest known site of its type in southwest Wales and it represents the beginning of one of Carmarthenshire's most enduring industries. Some fundamental questions still remain unanswered regarding the provision of water and the layout of the furnace and its associated blowing and casting houses. It is a scheduled ancient monument (SAM Carms 227).

Extension of the scheduled area

The area currently scheduled does not include the domestic building, the higher ground to the north of the furnace - which includes the likely area of the charging ramp - nor the northern end of the trackway. The scheduled area should be extended to include these features.

Remedial works

There are some immediate and pressing problems that require remedial action to make the site safe and to ensure its longer-term survival. The large tree growing on the furnace is probably best left because of its size and the way it has become integrated into the structure, even though it will eventually fall and demolish part of the northwest corner of the furnace. The smaller trees and vegetation growing on or close to the other structures could be removed relatively easily by controlled felling and then allowing their root systems to decay naturally.

The unstable gable walls of the domestic building could be lowered under archaeological supervision to make them safe. This would allow for the recording of any structural detail, including mortar analysis, before the walls finally fall and that information is lost.

Answering the archaeological questions

The biggest question remaining about the site is the layout of the furnace and its blowing and casting houses. To answer this a trial trench located parallel to either the southwest or southeast wall and positioned *c.*3-4m from the wall should retrieve enough evidence to identify whether the trench is in the blowing or casting house. The trial trench could include part of Structure 1 in order to try to elucidate its nature.

A single trench inside Building 1, possibly excavated either side of the internal wall so that parts of both rooms are investigated, could provide evidence to suggest a function for the building.

Part of the interior of the domestic building could be cleared and excavated, once it had been made safe to investigate the internal form and if possible elucidate its function.

This small-scale targeted excavation could provide a wealth of information that would allow a good understanding of how this site operated, which would aid the future management of the site and its individual components. Furthermore, the information

would allow a much more refined interpretation of the site and of the operation of an early post-medieval charcoal-fired blast furnace, which would be of value for academic and popular interpretations and publications.

Presentation, interpretation and education

The site is located on private land away from public access and in an area of wooded and sometimes difficult terrain, furthermore, some of the structures are unstable and in a dangerous condition. Therefore, it is not entirely suitable for public or educational visits. However, the small-scale targeted excavations outlined above could provide the background information for the layout and operation of the site, which could be used for some kind of graphic reconstruction for use in interpretive material and educational packages. This could be in a printed format, for example, leaflets or worksheets, or a full three-dimensional reconstruction of the site available on CD-rom for use in schools, colleges, the SMR, libraries and other relevant institutions.

FURNEIS PONTIETS (PRN 30707)

This site has no statutory protection. It should be further investigated through a programme of topographic survey to define, if possible, the extent of the site, the lines of the watercourses and any surviving structural remains.

THE LLANDYFAN FORGES (PRNs 44441 and 44446)

Both the Old and New Forges are currently scheduled ancient monuments (SAM Carms.223), however, protection of the sites through scheduling may no longer be a viable option in isolation. The following recommendations have been devised to try to offer a more flexible approach to their management to protect the standing remains and the other evidence on the site.

Vegetation growth

There are a number of urgent problems that need to be addressed to protect the standing remains. The most pressing of these is the vegetation, most notably the large mature trees, growing on the structures themselves. Fallen trees at the Old Forge have removed sections of the dam structure, as well as parts of the forge and other buildings. Similarly, falling trees at the New Forge have also removed sections of masonry. It is very likely that some of the trees currently growing on the structures will not survive for much longer resulting in the loss of even more of the structures. Therefore, it is recommended that a programme of felling be instigated to remove the larger trees from the structures at both sites, but particularly and most urgently from the dam and the forge building at the Old Forge site, to prevent the further loss of surviving masonry.

The removal of the larger trees will open the canopy and encourage the development of the understorey vegetation. This should be controlled by regular clearance before the new vegetation has a chance to develop and become well established.

The impact that tree roots are having on the buried structures and deposits at either site is not known. It could be that the trees are fairly shallow rooted and not having

much impact at all, but conversely they may be causing significant damage below ground. Small, well-placed trial pits could be excavated to retrieve enough information to make an assessment of the extent, if any, of the below ground disturbance caused by the tree roots. These trial pits could, if carefully positioned, also answer some of the archaeological questions regarding the former operation of the site.

Flooding and waterlogging

Flooding and long-term waterlogging are affecting both sites. At the Old Forge (PRN 44441) site the active leat is constantly flooding the area between the dam and the forge building, which is leading to increased waterlogging of the central area of the site, where a waterlogged organics rich soil, 0.25m-0.3m, has developed. Room 1 of the New Forge has permanent standing water, to a depth of at least 0.2m, which must be seeping in from the wheel pit outside the southwest wall.

The standing water in Room 1 of the New Forge (44446) will be having a detrimental affect on the lower courses of the standing structure, ultimately leading to the destabilisation of the structure. It is not known what effect the flooding and waterlogging of the central area of the Old Forge site is having. Probing could be carried out to determine the depth and extent of the waterlogging, but it would not be able to answer questions regarding the condition of the below ground deposits. A small-bore core, 4cm, diameter, taken using a hand auger, through the deepest part of the deposits may provide useful, but limited, information on the nature, depths and condition of the below ground deposits. Another option may be the excavation of small trial pit, which would provide the information required regarding the waterlogging and condition of the deposits and at the same time it may reveal some structural evidence.

Interpretation and display

The two forge sites are important as they represent the beginnings of what has become one of the bedrock industries of Carmarthenshire. They are crucial in understanding the early development of the ironworking industries and their potential for education, interpretation and presentation should be considered. Their location alongside the road makes them easily accessible, although the road is narrow and it does have fairly heavy lorry traffic, and access would obviously have to be negotiated with the relevant landowners.

In order to facilitate the interpretation of both sites a selected and targeted programme of trial pits and rubble clearance could be undertaken to recover information from which a reasonable understanding of the functions of the main buildings may be achieved. This could lead to both an academic and a popular interpretation of the site. The latter could include some form of visual reconstruction for use in interpretative and educational material. It may be possible to explore various partnership arrangements for funding this part of the works, including local initiative groups such as ACTT and local business such as the nearby Brecon Carreg spring water bottling plant.