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The Barrow Steam Corn Mill, 1870-1972

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Prior to redevelopment of a large area adjoining Hindpool Road and Cornmill Crossing in Barrow-in-Furness, Greenlane Archaeology was commissioned to carry out a series of archaeological investigations. The largest element of this was the excavation of the entire remains of the former Barrow Steam Corn Mill, which was established in 1870 during a time of rapid growth for the town. Documentary study and the results of the excavation showed that the mill went through several stages of expansion and improvement, all of which reflected the changing nature of grain milling at the time, and many of which utilised the most advanced techniques and technology available. The expansion of the mill reflects the industrial growth of Barrow-in-Furness during the late nineteenth century, realised by the newly created dockyard, itself the product of the wealth and vision of a syndicate of local businessmen. At its peak the mill was part of an international trade in grain and flour and was at the forefront of both the local use of electricity and the national use of sprinkler systems. It remained in operation for almost 100 years, closing in 1967, subsequently being destroyed by fire in 1972.

THE proposed development area included six separate nineteenth-century industrial complexes (Greenlane Archaeology, 2006), the earliest of which was a patent slip established in 1847. This was the first to be established in the town and the precursor to the massive ship yards that have come to dominate the local economy ever since. The slip was subsequently buried, however, as the shoreline was consolidated to form part of the dock system, and the reclaimed ground was occupied by a ropewalk, iron and brass foundry, and the town's first gas works. The majority of these were established in the 1860s. During the investigations, various types of recording work were undertaken across the whole site, and seven standing buildings relating to the iron foundry were examined while a watching brief was maintained during their subsequent demolition (Greenlane Archaeology, 2007a). The largest single structure on the site, however, was a steam corn mill (Figure 2 and Figure 3), of which no physical evidence remained on the surface, although it had been located during an earlier watching brief (Greenlane Archaeology, 2007b). As the remediation work required all of the footings of the buildings to be removed, and the foundations of the corn mill were evidently quite well preserved, a full programme of excavation and recording was requested by the local planning authority.

The site is located on the south-west side of modern Barrow-in-Furness (Figure 1), on the north side of the system of docks that dominate this part of the town (centred on NGR SD 19496 69003). It is adjacent to Hindpool Road, the A5087, approximately 8m above sea level. This area saw considerable nineteenth century development and the subsequent decline in these traditional industries has paved the way for extensive modern improvement.

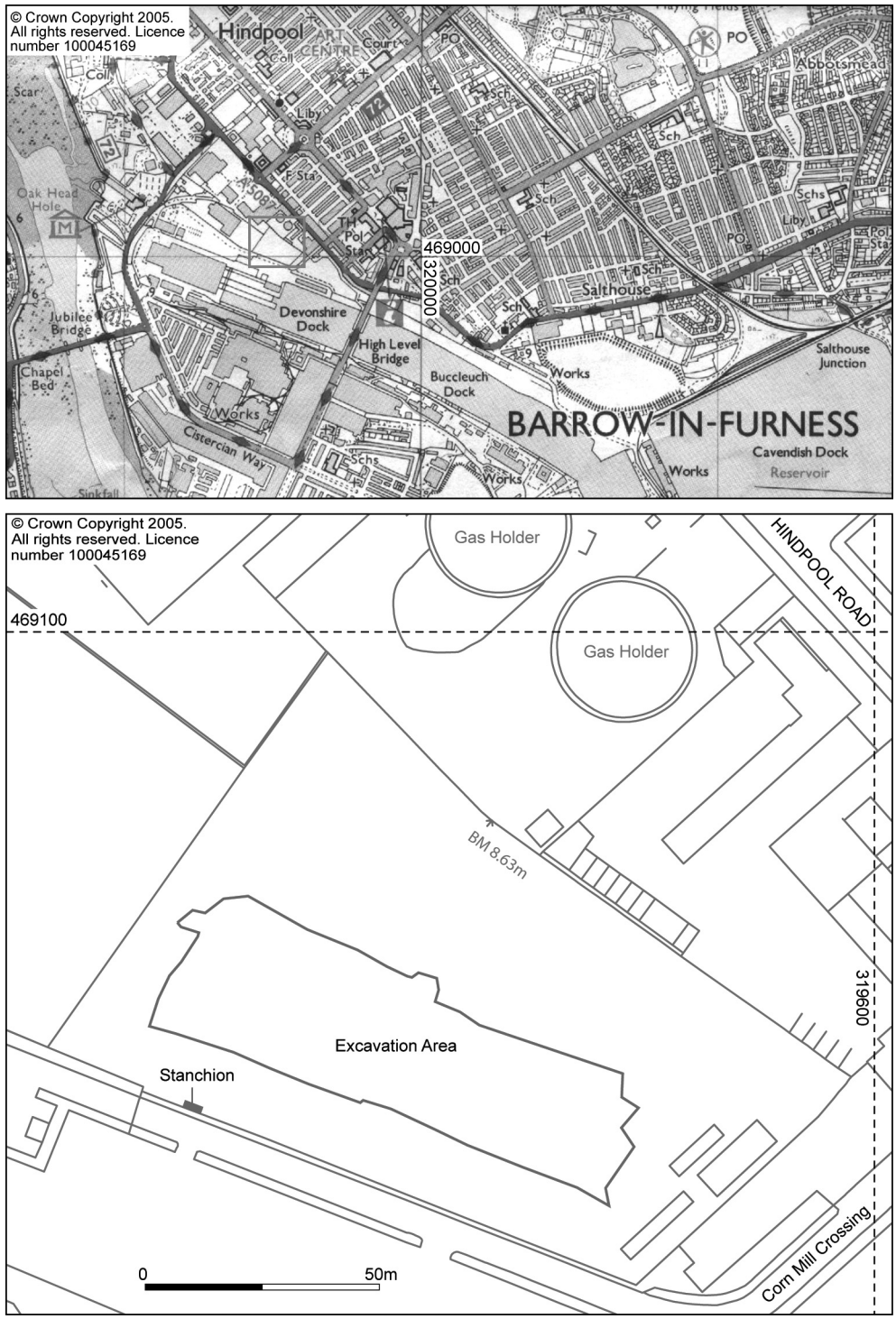


FIG. 1. Barrow Steam Corn Mill site location plan.

Grain milling in the late nineteenth and early twentieth centuries

The history of the physical evolution and archaeology of steam-powered corn mills has perhaps been overlooked in comparison to, for example, textile mills, but it is evident that during the late nineteenth century they were undergoing something of a revolution. The history of this process has already been well-documented, specifically the introduction of an important piece of new technology: chilled iron rollers (Tann and Jones, 1996). Traditional millstones were still widely used in the late nineteenth century even in large scale production sites, however, although some improvements had been made, such as the addition of a metal distributor that allowed a cooling draught to be passed through the mechanism to prevent overheating (White, 1856). By the late 1870s, however, the millstone had been 'almost totally discarded' in many cases, the principal change being the adoption of rollers, which were first used in Austro-Hungary and introduced to Britain in 1878 (Simon, 1889). These, combined with high quality precision engineered machinery and an almost entirely automatic operating system working on the principle of gradual reduction minimised the need for manual handling and guaranteed speed, efficiency and quality.

The typical process of the late nineteenth century saw the grain first passed through a grader, which divided it into three sizes (Simon, 1889). Each size was then sent through fluted rollers to break open the individual grains, and then passed through a centrifugal dresser to remove any dirt or other particles. Following this, the broken grain passed through a further set of fine rollers to extract the kernel and clean the bran, after which they were separated in a rotary scalping or sifting machine, a process that could be repeated several times through different grades of machine. This would gradually reduce the grain and completely separate the bran so that it did not contaminate the flour, although further separation of those parts of the grain not suitable for high quality flour (the middlings) could be made via the use of purifiers, which again removed impurities and graded the middlings so they could be treated in dressing machines depending on the intended finished product. Each dressing machine could then produce its own flour, which was delivered to a conveyor allowing it to be mixed if required to produce different grades and types. Even the final packing of the flour into sacks or barrels was automatic, and only the weighing of the finished product was likely to involve any great amount of manual labour. The large quantities of dust that were inevitably produced during the various grading processes were collected by an exhaust fan and expelled by a 'cyclone' to a suitable point of collection.

During the early twentieth century this method of operation continued to be used, although improvements were made to the machinery (Creak, 1913). In some cases the initial preparation involved the removal of intrusive seeds and other impurities using a 'cockle cylinder' and the washing of the wheat, which facilitated both the removal of stones and the softening of the harder varieties. One of the major improvements during this period was the addition of the plansifter, which often replaced the centrifugal sorters and comprised a set of superimposed sieves constructed from silk or wire that divided the flour into its different types. Although motive power was typically still provided by a steam engine at this time, generally running everyday except Sunday as the mill operation was almost entirely automatic, the use of electricity was becoming more common. Storage of the wheat in a silo at the point of entry to mills of this

type, which were almost always situated in a port-side location (Round, 1914), had also begun to be universal at all large flour mills. These were often built of sheet steel, but concrete (Stratton, 1999) and timber were also commonly used and they were generally fitted with a hopper to enable the grain to be taken out and a distributor to separate out the different weights and sizes of grain. Silos were generally sited at some distance from the mill to reduce the risk of fire and therefore lower the insurance costs.

The historical development of the Barrow steam corn mill

The steam corn mill in Barrow was established by the formation of a limited liability company in 1870 (Mannex and Co., 1882, 35), which comprised several members of a business 'syndicate' made up principally of the shareholders of the Furness Railway Company. This group was essentially responsible for the growth of Barrow-in-Furness and the creation of several of its major industries. During the 1860s and 1870s they invested heavily in a number of schemes around the town to such an extent that 'Holdings in Barrow were interlocking, and the bulk of shares were held by a small number of extremely wealthy men' (Pollard, 1955, 215). The capital invested in the mill totalled £7,506, and in 1872 it is said to have employed 50 people, making it one of the more expensive schemes established by the 'syndicate', and one the major employers in the town (Marshall, 1958, 338-346). The establishment of a corn mill may have been intended at an early stage in the planned development of the dock system completed in 1867 (Barnes, 1968, 91), as the north side of the Devonshire Dock, on which it was located, was initially allocated for traffic carrying grain and jute (Stileman, 1880). The 'syndicate' also established a jute works in the town in 1870, ostensibly to provide work for women and children who were considered unsuitable for the town's male dominated industries such as the furnaces or shipyards, but nevertheless also required work (Richardson 1881, 84). The 'syndicate' also acquired large land holdings, although legal difficulties meant that many were only held nominally or by agents such as local builders (Pollard, 1954, 111). One such builder was William Gradwell, a local brick maker, closely associated with the 'syndicate', who had become established as the principal building contractor in the emerging town by 1855. It is perhaps not a coincidence that he was appointed to construct the corn mill (Richardson, 1881, 86).

The operation and arrangement of the Barrow steam corn mill

The original mill building was described as being 180 feet long and five storeys tall, with a 55hp engine made by Messrs Westray and Forster of Barrow, while a Mr Smith of Leeds made the remaining machinery. The complex was designed by a Mr Swallow, also of Westray and Forster, and contained nine pairs of millstones (Leach, 1872).

The mill soon expanded; in 1874 it doubled in size with the addition of another wing housing up to 18 pairs of stones (Richardson, 1881, 86). The influence of the syndicate was not enough to protect it from economic fluctuation, however, and by 1880 a slump that had begun in the 1870s finally led to the failure of the company (Mannex and Co., 1882, 35-36). The mill was acquired by Messrs Walmsley and

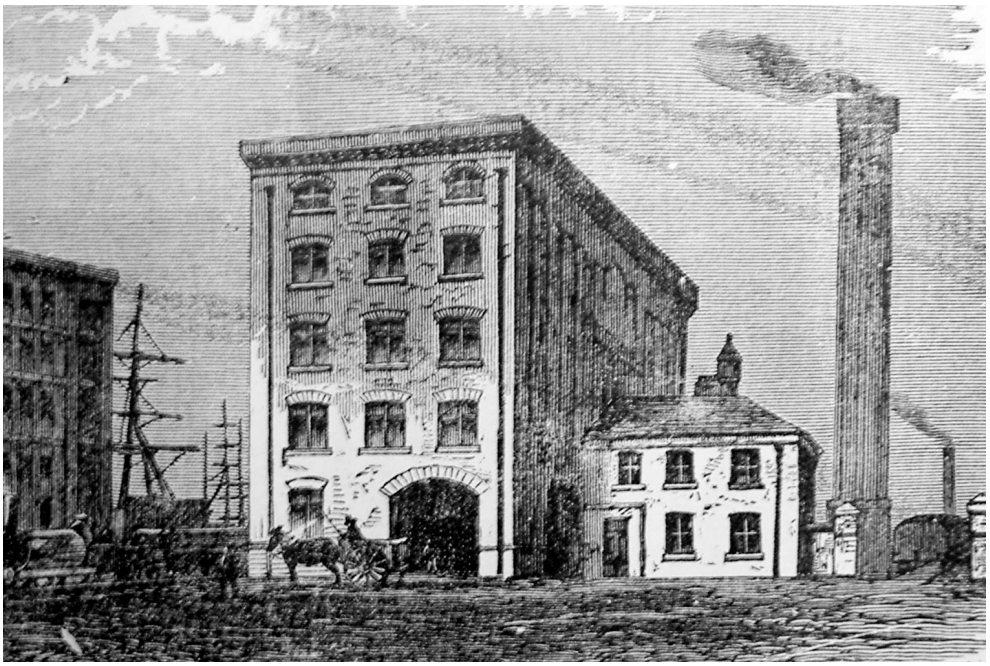


FIG. 2. The corn mill in 1872 (Phase 1), viewed from the east (Leach, 1872).

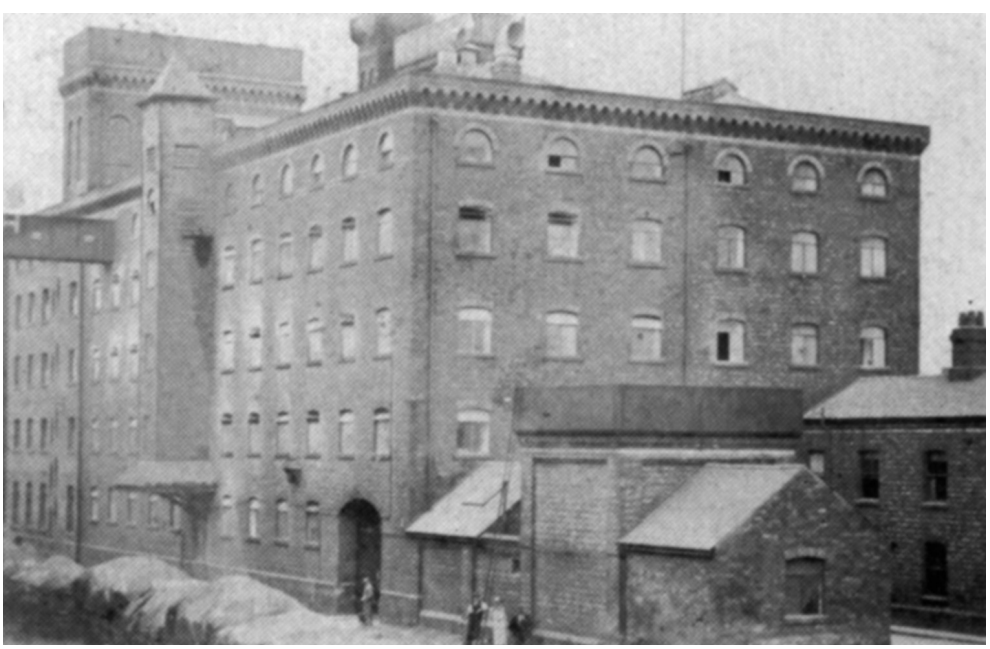


FIG. 3. The corn mill in 1907 (Phase 3) from the south (Garbutt and Marsh, 2002).

Smith of Lancaster in 1881, who set about extensively modernising and improving the site. Amongst their improvements, early in 1885, was the installation of plant to provide electric lighting which 'with the exception of the arc lighting at the Ramsden Dock, was the earliest application in the town' (Anon, 1901). The mill is also recorded as having been the first of its type to have an automatic sprinkler system installed, to the designs of John Wormald. It is not clear when this work was carried out but it is unlikely to have been before 1886-87 during which time extensive tests on the effectiveness of such systems in corn mills were carried out (Wormald, 1923).

In 1903, however, the mill was sold to Messrs Edward Hutchinson Ltd. of Liverpool (Melville, 1974), and under their management the complex was arguably at its most productive and successful. It imported grain from all over the world, including Russia and Sweden (Evans, 1992), and it employed over 100 men and women (Melville, 1974). They too made numerous improvements to the site, including the erection of four silos with a capacity of 10,000 tons of grain in 1904, and an additional five storey structure containing 'plant for the cleaning and preparation of wheat for the Mill, engine and dynamo room, and shops for repairs staff' in 1905 (Appleby, n.d., 103-104). During the mid twentieth century the mill was most well-known for the production of 'Diamond 'O' Flour', which was distributed across the north of England (Melville, 1974). By at least the 1930s, however, it was also producing kibbled corn and flaked maize, indicating a change to making animal feed (Private Collection, 1933), which was certainly the case by the 1960s (Barnes, 1968, 104). It remained in operation for over 60 years under Hutchinson's management, despite apparently being damaged during an air raid in 1941 (Norman, 1994, 40), until finally ceasing operation in 1967 (Melville, 1974). Some demolition apparently took place at this time, but the majority of the structure remained standing and was used as a warehouse and garage by a fruit and vegetable wholesaler until it was destroyed by fire on 12 November 1972 (Anon, 1972). The site was subsequently used as a coal depot and in 1990 the majority of it was covered with a layer of concrete to further facilitate this function (Tony Clowes, *pers. comm*).

Excavation

The excavation of the corn mill was carried out as four tasks: the initial removal of the reinforced concrete slab that covered the site, the removal of the demolition rubble within the underlying rooms (by machine where possible), hand excavation and cleaning of the remaining areas, and a watching brief on the final demolition. The excavation archive comprised three main elements: the compilation of written records, a survey resulting in the production of accurate site plans, and a photographic record. The interpretation of the excavated results was aided by several of the documentary sources already listed, particularly the contemporary maps, engravings and photographs. An engraving of 1872 by F. Leach depicts the mill shortly after milling operations began and is the earliest representation of the building (Fig. 2); as such it proved especially useful in understanding the early operation of the site.

Results

The building was evidently demolished soon after the fire of 1972, so only the truncated remains of parts of the ground floor and basement areas remained. Fortunately the entire footprint of the building was preserved and could be recorded; this was enough to reconstruct four broad phases of building at the mill and answer many questions regarding the physical layout of the structure, the operation of the engines, and the relationship with transport networks that allowed fuel and corn into the building and flour out. The footprint of the mill was 142m x 28m and was orientated north-west/south-east although for the purposes of descriptions in this article only the four cardinal points have been used (Fig. 3). The project also examined the formation of the dockside on which the mill building was located as well as compiling an assemblage of the many types of brick used on the site, several of which were made by the local builder William Gradwell (see Fig. 12). Analysis of the various bricks used in the construction of the buildings proved very useful in helping to phase the buildings and gain rough construction dates in certain areas, especially in conjunction with map and photographic evidence.

The origins of the site

As already outlined a patent slip was constructed on the edge of the development area in 1847. However, no trace of this was found during the excavation of the site as this feature would have been deeply buried by dumped deposits that were used to form the dockside, or 'ballast wharf' as it was termed in an 1856 plan of the proposed docks (reproduced in Marshall, 1958, 230). The material used to consolidate the dockside was evident at the site and consisted of re-deposited natural clays which incorporated some nineteenth century pottery and clay pipe fragments. Some of the *in situ* natural grey marine clay representing the original ground surface was located beyond the north end of the footprint of the corn mill during the initial watching brief (Greenlane Archaeology, 2007b, 10), but it appears that the corn mill itself was situated on an area of entirely reclaimed ground. The enormously deep foundations of the main mill buildings that were revealed during the final part of the demolition process were presumably in part necessary as a result of this.

Phase 1 1870-1871

The first phase of building represents the plan of the original steam corn mill, as built in 1870-1871 (Marshall, 1958). Structural elements recorded from this phase include the engine room (14), column bases or stanchions within the main body of the mill (5), the remains of the chimney (18), the original offices and possible drying kiln (13), and the truncated remains of small buildings to the north-west (Fig. 4). The nature of the subsequent phases of development seems to indicate that the intention from the outset was to expand the mill as soon as it was economically viable; this is also suggested by the location of the chimney, which was constructed some distance to the west of the main building.

The excavation of the engine room (14) revealed a brick-built engine bed that was at least 8m long, surrounded by a channel and divided longitudinally by a deep flywheel

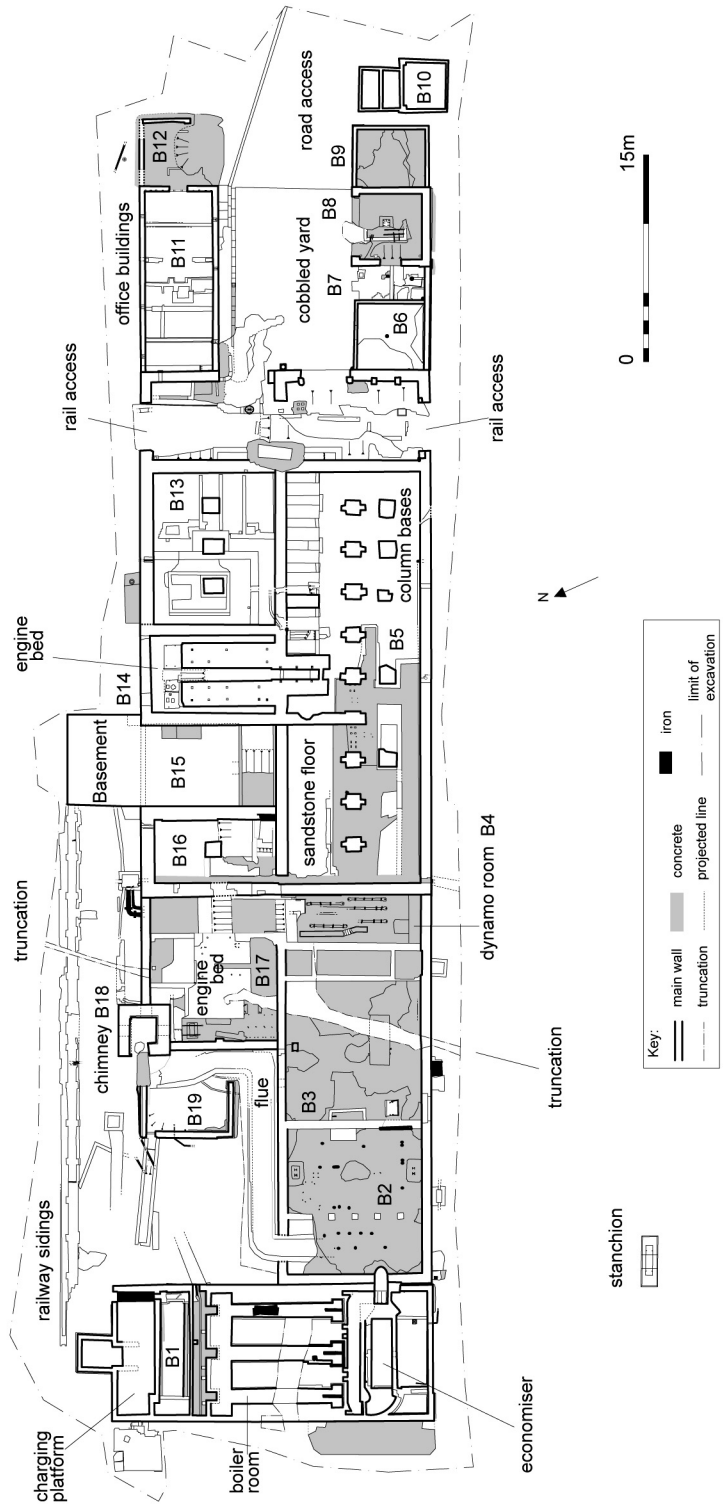


FIG. 4. Building elements (B1-B19) and other features revealed during excavations.

pit/channel. Part of the fill of the flywheel pit was removed and revealed its depth to be nearly 2m; below the demolition rubble there was a 1m thick deposit of clinker, beneath the clinker was a layer of broken window glass. This sondage revealed that the brickwork of the engine bed incorporated substantial red sandstone blocks and that the entire structure was bedded into the re-deposited yellow clay which was evident at the base of the pit. The brickwork and sandstone of the engine bed housed numerous bolts and tie rods that would have held the engine in place, and during the subsequent demolition it was evident that these rods ran through several courses of brick sandwiched between two thick sandstone blocks.

The stanchions within this first phase of the main mill building (5) formed two rows, although it was not clear whether these were contemporary or not. The northerly row of stanchions were cruciform in shape and constructed from red brick; the central location of these within the building would suggest that they were original. It seems likely that these were the bases for iron columns that would have supported the beams of the upper floors. The row to the south were approximately square and formed from mortared sandstone blocks, these may have formed the support for vertical driveshafts. It is likely that these were original too given the difficulties that would have been faced adding them at a later date; the use of the local red sandstone was also exclusive to Phase 1. In the north-east part of Building 5 there was a row of eight brick built bases that formed tanks or shaft bases, which at the time was filled with clinker. These structures are evident to the east of the red sandstone floor which also forms part of Building 5 (see ranging rods, Fig. 5). The purpose of these structures

FIG. 5. The Phase 1 engine bed (14) to the right of the large cellar, western stanchions of Building 5 in the foreground. The dynamo room (4) and Phase 3 engine bed (17) can be seen at the left of the shot. (Photograph by Aerial-Cam. www.aerial-cam.co.uk)

remains unknown although it seems likely that they supported machinery, perhaps connected with transporting the finished flour down to the ground floor. Excavation of the westernmost tank revealed a deep accumulation of broken red sandstone pieces below the usual demolition rubble, which would suggest that the bases went out of use well before the building was destroyed. While the northern ends of the tanks were formed by the north wall of Building 5 and enclosed, the southern ends appear to have originally been open and were enclosed with irregular brickwork at a later date.

The chimney base to the west of the main bulk of the mill (18) appears to be in its original location. While the position of the original flue could not be ascertained the remains of two flues connected to the chimney were recorded, one cutting through the other, but these evidently belonged to later phases. The chimney, which was square in plan, was constructed from red brick, with an internal lining of yellow firebricks. The base of each elevation of the structure incorporated a semi-circular arched aperture; the west arch was the only one that had not been bricked up although it had collapsed under the weight of falling masonry.

The early map evidence indicates that Building 15 occupies an area that was part of the original plan, however it is probable that the basement found in this area represents, at least in part, a later phase. It is very likely that the area of Building 15 was the location of the original boilers/flue and it is possible that coal could have been delivered and stored in this area by the rail links to the north of the building.

Walls within the area subsequently forming Building 13 (see top right Fig. 5) were clearly constructed as part of the original mill design, Leach's engraving from 1872 (Fig. 2) shows a two storey structure of domestic appearance, which has consequently been interpreted as the original mill offices. The Ordnance Survey map of *c.*1873 (Fig. 8) suggests that there were two separate buildings in this area separated by a narrow gap, the east part being the offices, while the west seems to be linked to the original engine room. Excavation of this area bore this out, with a smaller room in the west part of this area and a separate building occupying the east part. Kiln tiles found within the west room suggest that it may have been the location of a drying kiln; and substantial quantities of charred oats were recovered from residues found within the kiln tile apertures. A tall chimney is visible on Leach's engraving which further supports this idea, the base of which is probably evident in the excavated remains (Figs. 4 and 6).

The rail lines to the south were not exposed during the excavation, however the branch line that led into, and out of the south-east corner of the mill building was located (entrance evident in Fig. 3). This probably represents the point at which the flour entered the mill from the opposing warehouse (Fig. 2) and left the mill to be shipped. After the turn of the century the mill was fed directly from four dockside silos via bridged conveyers (Fig. 3).

The remains of a small and isolated building (20) to the north-west of the chimney were also revealed during the excavation; these buildings are evident on the *c.*1873 Ordnance Survey plan showing the mill although their exact function is unknown.

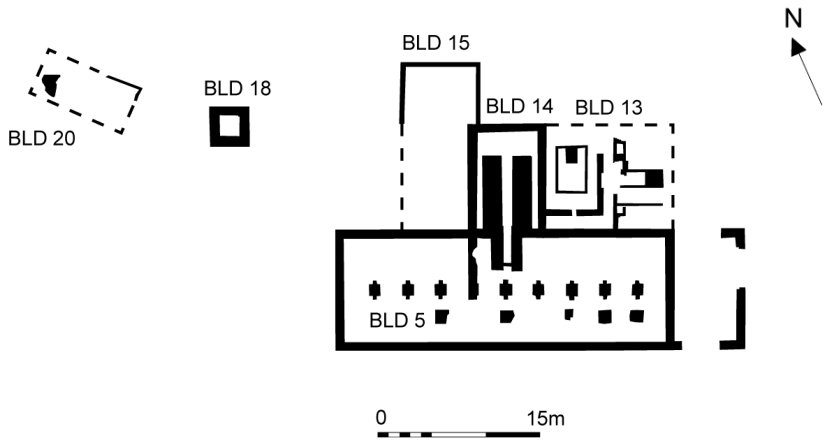


FIG. 6. Plan of Phase 1 elements (1870-1871).

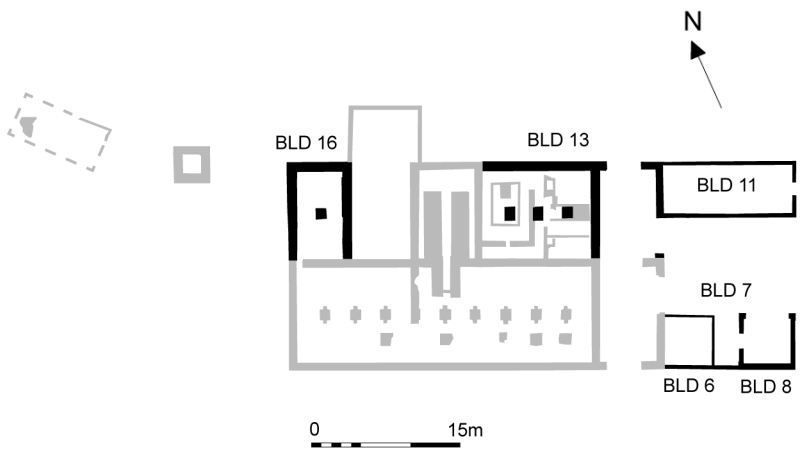


FIG. 7. Plan of Phase 2 additions (1874).

The physical remains of the buildings were represented by red brick flooring and walls which had later been truncated by the re-organisation of the rail tracks to the north of the mill. This building was easy to identify as it had a slightly different orientation from the main mill buildings (see Figs. 4, 5 and 6).

Phase 2 1874

Documentary sources reveal that the mill grew substantially between 1873 and 1874, the main developments at this stage including the re-development of Building 13, the addition of Building 16 as well as offices and out-buildings (Buildings 6, 8, and 11) to the east of the main mill structure, and the growth of the rail links to the north of the mill.

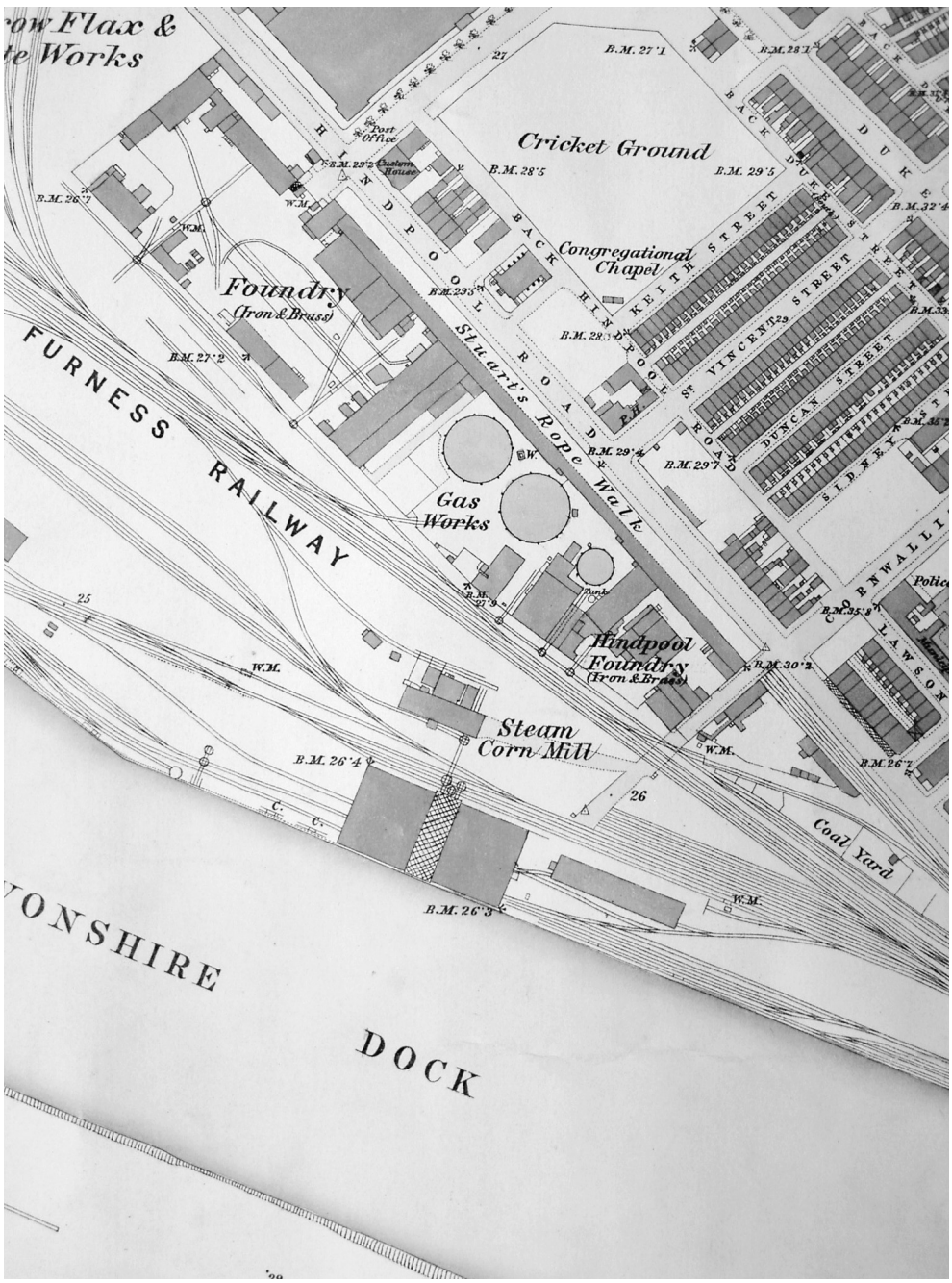


FIG. 8. Ordnance Survey Map, *c.* 1873 showing the corn mill and its surroundings.

The original office buildings and kiln within Building 13 were replaced with a five-storey addition, matching that originally built to the south. Later photographs (The Acme Tone Engravings Company Limited, 1900, and Fig. 3) show this addition, and the size of it suggests that the original north and east walls of these buildings were replaced in Phase 2 by more substantial ones. The enlargement or replacement of these buildings was evident during the excavation, as stanchions had clearly been inserted within Building 13 that truncated the original internal walls. The internal walls also stopped short of the outer walls, their partial truncation to facilitate the rebuilding of the wider north and east walls of Building 13 (see Fig. 4). This rebuilding incorporated a general eastwards expansion of the main mill building, which also enlarged the rail access way into the east of the mill (Figs. 3 and 4). The three centrally located stanchions were constructed from red brick and were undoubtedly added to support iron columns and beams to support the increased height. The new offices and administrative quarters appear to be represented by Building 11 to the east, which was also constructed in this phase.

Building 16 was added to the west of the site at this time, its exact function remains unknown although its location would suggest the possibility that it housed boilers, perhaps those belonging to this phase; a flue was exposed during demolition running east/west along the south side of this building. At the west end of this building there was a north/south concrete channel, which had also been inserted through the earlier Building 5. At its south end the channel exited through the south wall of Building 5 and presumably drained into the docks, and at the north end the channel fed into a brick built drain (see Fig. 4). The drain to the north was also fed by two cast iron pipes that exited from Building 17 immediately to the west which belong in Phase 3.

A large number of the buildings to the east of the main mill building were also added at this time, and flanked a cobbled yard that was entrance for pedestrian and vehicular traffic. Building 11 to the north of the access yard represents the new office and administrative buildings that were paved on the southern side. Excavation of this area revealed the building had five separate rooms on the ground floor, two of which had back-to-back fireplaces linked to a central chimney. On the southern side of the access yard four buildings were added, two of these appeared to be little more than sheds. The most substantial building appears to have been a water tower (Building 8); a photograph dated 1907 (Plate 2) shows this to be a substantial brick structure with a tank on top. The water tower had substantial walls and a concrete floor with numerous drains, and during the watching brief conducted on the final demolition a large fuel tank was removed from below the reinforced concrete in the centre of this building but it seems likely that this was a later insertion when the site was used as a vehicle depot. It is probable that this block of buildings was built to deal with fire fighting before the sprinkler system was added to the mill.

Phase 3 1881-1911

This broad phase spans from the change in ownership of the site in 1881, and incorporates the extensive alterations and improvements that were made up to 1910/11. This phase represents a period of major re-organisation and development

at the mill that includes the introduction of electrical lighting (Buildings 4 and 17), a new boiler room (Building 1), general expansion of the mill's size and capacity (Buildings 2 and 3), and the evidence for the growth and development of the rail links to the north side of the mill. It is during this time that the mill was first fed directly from new silos at the dockside, and sprinkler systems were added.

Building 4 was evidently a dynamo room and had a concrete floor with various scars and channels in it (see Fig. 4). The scars presumably represent the position of equipment fixed to the floor with iron plates, while the channel, which still had *in situ* timber boards covering it, seems likely to have formed a conduit for cabling. The area represented by Building 17 was largely occupied by an engine bed that was constructed from huge ashlar blocks of fine-grained greenish-yellow and bluish-green stone, which were 0.50m thick. This engine formed part of the electricity generation equipment that ran the lighting at the mill; the blocks and the associated concrete flooring to the west and south housed bolts for associated machinery and conduit channels (see Fig. 2). The boilers that provided the steam power for this process were not located although they could well have been quite small. Documentary sources (Anon, 1901) state that Walmsley and Smith were responsible for installing plant to provide electric lighting at the mill in 1885, and it is likely that some or all of these structures relate to this. The high pressure steam pipes that exited the north wall of Building 17 and feed into the drain to the north of Building 16 are something of a mystery as their origin was never ascertained. It seems likely that these relate to the main condensing engine, or could be re-used pipework that fulfilled a different function entirely.

The next development appears to be the construction of the new boiler room (Building 1) some distance to the west of the main mill building. This can be seen for the first time on a photograph from 1904 (Myers, 2006, 29) and was built in conjunction with a new flue system linking the boiler room to the chimney. Later in the same year the main mill building was expanded westwards, over part of the new flue, to join with the boiler room and chimney. A butt join between the mill building (2) and the boiler room indicates this order of events; the double wall in this area indicating the boiler room existed first (see Fig. 9). Once the main mill building was expanded it was linked to the newly constructed silos on the dockside via a conveying bridge delivered in January 1905 (Myers, 2000, 26) allowing corn to enter the new area of the mill; it appears from photographs that the old bridge from the dockside warehouse was retained. Evidence for the new conveyor consisted of a substantial stone built stanchion that would have supported the bridge and was situated between the rail lines. These developments occurred after the removal of the steam-powered dynamo whose life was cut short by the construction of Barrow's first electricity generating station in 1899 (Barnes, 1968, 114).

Excavation of the boiler room (Building 1) revealed it to be in very good condition (Fig. 10). The relative lack of truncation by later activity in this area allowed the following processes to be easily re-constructed: the coal was unloaded into a sump by train from the rail lines to the north and could then be shovelled into the three Lancashire boilers from the charging platform; the heating process was made more efficient by the presence of an economiser, which was warmed by smoke exiting the

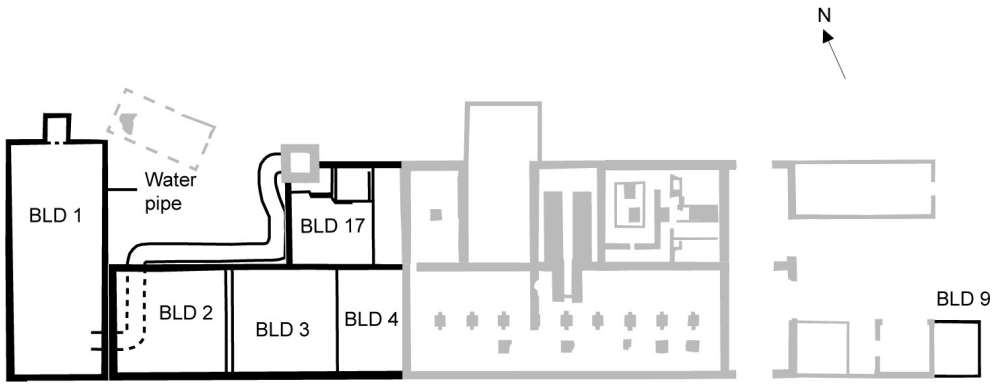


FIG. 9. Plan of Phase 3 additions (1881-1911).

boiler room through the large flue to the east. The boilers had been removed but their concave supports constructed from fire bricks were evident, and a couple of substantial curved and riveted iron plates, presumably from a boiler, survived along with some of the purple, silty boiler residues. The flue itself was a substantial inverted 'U'-shaped brick-built arch that was over 35m in length and during its excavation it was evident that it had truncated an earlier flue system. Unfortunately the origin of this earlier flue could not be found during the demolition phase, and the location of the earlier boilers remains a mystery. It is assumed that the new boiler room still fed steam to the main engine in Building 14 although the associated pipework was never discovered.

The rail sidings that ran to the north of the mill were evident in the form of a pair of long walls with a flat paved area between that was 0.65m wide (see Fig. 5, top left). Areas of black clinker were observed to the north of these walls. While there was a rail line in the original phase of the mill's construction these sidings were clearly later, relating to the expansion of the rail network to the north of the mill. This was shown by the fact that these sidings truncated the small building to the north and west of the original mill, which is evident on the Ordnance Survey Plan of *c.* 1873. This building is also evident on Fig. 5 towards the top left side, its two truncated walls having a different alignment from the other mill buildings.

Phase 4 1911-1967

This phase spans the period between the last recorded major improvements in 1910/11 and the closure of the site in 1967, and comprises relatively minor alterations, some of which probably relate to activities taking place on site after the mill had gone out of use. (See Fig. 11)

Building 19 comprised a C-shaped brick built wall that was built around and partly over the flue from the Phase 3 boilers as it neared the chimney. The wall of this building was constructed on concrete footing, an aperture in the north-west corner held a brick-built channel with a concrete base that housed a ceramic pipe. The purpose of

FIG. 10. The boiler room (Building 1) from the west. The photograph shows the location of the three boilers in the centre with the flue running under the floor of Building 2 from the area of the economiser, and out to the chimney. To the north of the boilers the charging platform and rail fed coal tank are evident. (Photograph by Aerial-Cam. www.aerial-cam.co.uk)

this structure remains unknown although it seems likely to relate to the functioning mill.

Building 10 comprised a large rectangular pit some 2m deep, adjoining which were the remains of two smaller rectangular structures. The function of this building is unknown, however it is likely to be associated with the garages that occupied the site after the mill was abandoned. Building 12 falls into the same category and appeared to represent the floor of a garage with the bases of the rear and side walls.

Finds

The finds from the site were largely late in date and difficult to identify and came mainly from the overburden and/or demolition rubble that covered the site and filled many of the excavated rooms. A majority were iron objects that revealed very little new information about the operation of and conditions within the mill. Largely remnants of fittings and fixtures, they were often hard to interpret because of their badly mangled and corroded condition. As mentioned, kiln tiles were recovered from Building 13; these were made by the Fison family in Stowmarket who established a brickworks there in 1830. This company was still operating well into the latter half of the nineteenth century, and is recorded as having invented an 'improved malt-kiln tile in 1862' (Crew, 2004). The date of these tiles therefore fits broadly within the period of operation of the corn mill, although their presence at the site was somewhat

FIG. 11. Plan of Phase 4 additions (1911-1967).

unexpected. These are the first recorded examples of Fison's tiles in Cumbria (Peter Crew *pers. comm.)*

A good selection of brick types were recovered from the site and catalogued for future reference (Greenlane Archaeology, 2007). Unfortunately a majority of the marked bricks were recovered from the demolition rubble and were not *in situ*. An attempt was made to correlate the dates of brick manufacture (where known) with the phase of the building in which the bricks were found; the results proved that there was largely no correlation between the respective dates. It is evident from the excavation that the majority of the bricks used in the mill's construction were supplied by Willam Gradwell.

Gradwell bricks

William Gradwell was closely connected to the construction of the corn mill and has already been mentioned in connection with the development of this, and many other of Barrow's industries; what follows is a short account of his influential career and illustrations of his own bricks. Gradwell first established himself in business at Roose in 1844, and as Barrow grew in size he was able to successfully ride the wave of progress (Trescatheric, 1985). By the 1870s his close connections to the establishment had seen his enterprise grow considerably; he was employing 750 men in 1872 and was also operating brick works in Ulverston by 1876 (McKeever and Layfield, 2004, 119-122). He died in September 1882, however, at the peak of his professional and local government career during which time he had become mayor of Barrow (Trescatheric, 1985). It is not known when his business interests were wound up, although it is suggested that the brick works ceased operation about 1900 (Glasgow, n.d.) His bricks therefore would be likely to span the early phases of the corn mill's development, approximately 1870-*c.*1900. Accurate information regarding the dating and chronology of his bricks is lacking, and it is hoped that the publication of these results will at least help remedy this situation. Further refining of the dates for some of

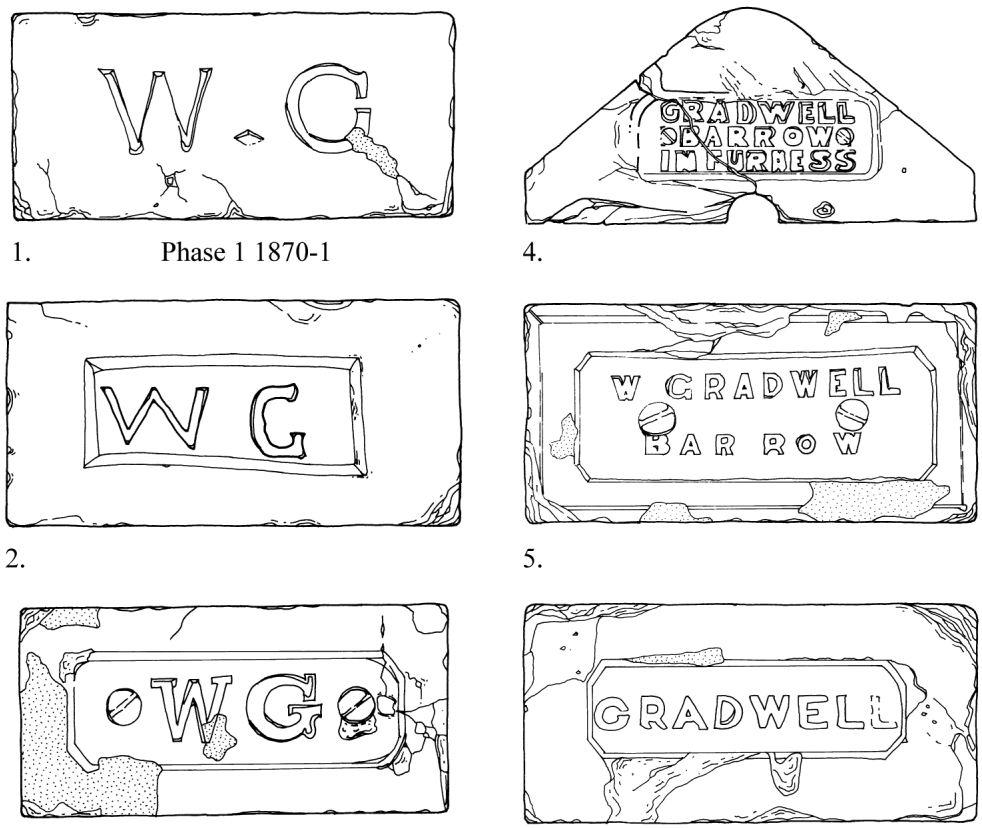
these bricks can hopefully occur if they are subsequently recorded *in situ* within other buildings of known date. The brick types illustrated in Fig. 12 are arranged in what is thought to be chronological order. Only brick types 1 and 3 were recovered *in situ* and therefore can be closely dated. A Gradwell brick with a stamp mark identical to brick type 3 has also been recorded at 104 Abbey Road, Barrow, which was probably built in 1874-5 (Greenlane Archaeology, 2008, 29), and suggests the date range of this brick type is relatively limited.

Conclusions and significance

The steam corn mill at Barrow-in-Furness is thought to be the only one of its type to have been archaeologically investigated although the standing remains of one in Greenwich have been examined (Clarke, 2002). Certainly, it is likely to be the only case where the entire footprint of such a site has been excavated. The initial desk-based assessment and subsequent research also provided an opportunity to collate sources relating not only to this site but to similar sites and to gather contemporary accounts regarding the revolutionary developments in corn milling technology that were taking place at the time. In most cases, the results of the excavation can be connected quite closely with the historical record of the site, particularly the recorded changes in ownership and the associated developments that this brought about. It has also identified details of the methods of construction and organisation of the site, specifically those relating to its position on a wharf constructed largely from redeposited clay, and also the apparent forethought in site layout that allowed almost uninterrupted expansion over a period of nearly 40 years.

There are, however, areas of uncertainty and questions that arise as a result of the excavation. Important details of the site organisation are uncertain. It is not clear where the water supply was for the boilers; many large steam-powered mills, textile mills in particular, were provided with their own reservoirs (Holden, 1999) or drew water from associated canals (Miller and Wild, 2007). Steam corn mills, which were inevitably built in dockside locations to facilitate the trade in large quantities of grain (Tann and Jones, 1996), would probably have found this difficult, and salt water taken from the dock would surely have been unsuitable. In this case it seems likely that water came directly from the mains, which was established in Barrow in 1863 (Barnes, 1968, 114). An iron water pipe was evident entering the east side of the boiler house (Building 1) at the east end of the channel just north of the boiler room (Figs. 5 and 9); this may have supplied mains water during Phase 3. A large structure projecting above the roofline of the main part of the mill is evident in several early photographs of the site (Fig. 3, The Acme Tone Engravings Company Limited, 1900; Myers, 2006); this is almost certainly a water tank and may well relate to the sprinkler system discussed below.

The apparent presence of a drying kiln on the site is also mysterious as it is difficult to imagine how it could have dealt with the industrial-scale quantities of grain being brought to the mill. Its position within Phase 1, when the complex was at its smallest and, in a sense, most traditional (that is, still using stones for grinding, which it did until Phase 2) is undoubtedly significant. It is perhaps the case that initially the mill



1. Phase 1 1870-1 4.

2. 5.

3. Phase 2 1874 6.

FIG. 12. Selection of Gradwell bricks at a scale of 1:4. The only Gradwell bricks illustrated to be found *in situ* were 1 (Building 5, phase 1) and 3 (Building 6, phase 2). (Illustrations by John Godbert.)

took in a reasonable quantity of grain from local producers that needed drying, unlike that imported from further afield. It is also noteworthy that the sample of grain recovered from the drying kiln fragments was predominantly oats, which were a staple crop and much more widely consumed than wheat in the region into the eighteenth and nineteenth centuries (Crosby, 1997).

Subsequent phases of development, however, show that the complex was extremely modern with an early example of electric lighting, and the first automatic sprinkler system used in a corn mill anywhere in the world. Evidence from the excavation relating to these developments is relatively limited in most cases; the site of the dynamo houses was located but it is difficult to be certain which phase this belonged to. The enterprise was also part of an international trade in wheat, with shipments being made from Asia, Africa, and the Americas; the dockside location was exploited fully and the mill was able to take part in a global business that would not seem out of place in the modern world. The evidence for the sprinkler system is again difficult to ascertain within the surviving remains of the site. As mentioned above, early photographs show a large water tank on top of the building, which most likely provided the water, but all other

remains are lost. The presence of low basement areas apparently inserted beneath the original floor level in parts of Building 5 may connect to this, perhaps providing access for piping, but this cannot be ascertained.

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