Kepier Water Mill, Durham City: A Conjectured Reconstruction

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1 Introduction

Almost nothing remains of the water-powered corn mill at Kepier Hospital, about half a mile (1 km) downstream on the River Wear from Durham City[1]. The building burned down on Saturday 24th September 1870 to leave a hollow shell. A photograph taken in the 1880s in the Frith postcard series (Figure 1, [1]) shows the scene from the river bank to the south. In the centre is the imposing gatehouse of the otherwise demolished mediaeval Kepier Hospital, with a storage barn and lean-to cow shed to the north. Almost hidden by a tree is the farmhouse. To the south east, at the right of the photograph, is the Kepier Gardens Inn. This had been built in late Elizabethan times by John Heath as part of a gentleman's mansion overlooking his pleasure garden, but became a venue for public refreshment and recreation early in the 19th century. When business fell away after the mill ceased to be a destination for carters, the inn fell into disrepair and was demolished in 1892. To the left of the photograph is the ruined mill. This has gone too, perhaps stripped and recycled for building materials at the same time as the inn was being demolished. The remains of the weir at the front left in the photograph have also disappeared. Today, therefore, more or less all that remains is the silted up mill arch, and that is usually concealed in bushes and the invasive Himalayan balsam weeds which have taken over the river banks. Even the view of Figure 1 is no longer, as the riverside today is overhung by obscuring trees.

My own interest in the mill came about when I read again the excellent booklet on the history of Kepier Hospital by Dorothy M. Meade [2], and decided to paint a picture based closely on the panoramic view in Figure 1. There is one other similar photograph, K1 in the Gibby collection archived at Durham University library [3]. A detail from a third glass plate photograph from about the same time has been shown to me by Durham local historian Michael Richardson, now in his privately collected Gilesgate Archive. The resolution of all photographs is not high and none shows the mill ruin with sufficient clarity to make out its structure. In order to paint the ruin I needed confidence as to what it looked like in some detail, and that started me on the project summarised in this article.

It is the nature of research that things do not unfold in a straightforward way. My research has been in two phases. I wrote a first version of this article based around the photograph in Figure 1, and circulated it to a few interested persons. This pricked the memory of Martin Roberts, an architectural historian, who unearthed an image of a brush and wash drawing of the mill probably made round about 1780, Figure 2. This unique drawing is inserted into William Hutchinson's personal copy of his 'History of Durham' held in the library at Durham Cathedral, published in volumes

[1]Postcode DH1 1LB, Grid Reference NZ 28180 43290, Latitude 54.783726, Longitude -1.5633541.

between 1785 and 1794 [4]. The drawing may be by William himself or his brother, Robert, who died in 1773. As discussed further below, the mill looks from the drawing to have just a single storey while 100 years later the ruin is of a taller building, probably two storeys. I was therefore obliged to look for corroborative evidence that the mill had been significantly extended and rebuilt, probably between 1790 and 1820. Since the Kepier estate was owned by the Musgrave family of Eden Hall near Penrith throughout this period, myself and two colleagues (Pauline Hales, Adrian Allan) looked at that part of the Musgrave archive held at Cumbria Archive Centre, Carlisle. I also revisited the mill ruin, and searched old newspapers on-line using the British Newspaper Archive at *www.britishnewspaperarchive.co.uk*.

The Musgrave archive at Carlisle is not complete – many years are missing [5]. Most of what there is has not been catalogued so we spent a couple of days looking through boxes containing unlabelled bundles of papers, mostly deeds, leases, bills, vouchers and receipts, and a few letters from the managing agents. We found this sentence at the close of a letter dated 12th May, 1804 from William Taylor of Beamish, the Durham agent for the Musgraves, probably to Sir John or his manager at Penrith:

> The Mill will be completed against the 12th of May and is one of the convenient things in this Country; in my next I will send you a drawing of the building.

Frustratingly, the mill is not named as at Kepier though the body of the letter is about R. Renny, the tenant of the Kepier stone quarry. Even more frustratingly, I could not find the 'next' letter referred to, nor the promised drawing! We also failed to find a letter to Sir George Musgrave about the fire which destroyed the mill in 1870.

I know of no drawing, painting or photograph of the mill made in the years immediately before it burnt down. I have therefore tried to construct a consistent understanding of the building, drawing on the scant direct evidence supplemented by indirect evidence:

1. background history, including that from the Musgrave archive and 19th century newspapers,
2. a tithe map of 1845 and Ordnance Survey maps surveyed in 1857, 1894, 1895,

Figure 1: Photograph of Kepier Hospital taken in 1886 from the upstream southern river bank looking north. (Frith postcard, courtesy Durham Record Office)

Figure 2: Brush and wash drawing of Kepier c1780 in Hutchinson's book, Durham Cathedral library.

3. the three surviving photographs of the mill ruin and the Hutchinson drawing,

4. a personal surface examination of the site,

5. some knowledge of how water mills operated.

I have also found useful the present day aerial view from Google Maps (on-line), which has the facility to measure distances, and drawings and ground plan of Heath House, later the White Bear Inn or Kepier Gardens Inn, as given in Meade's booklet and available also on the internet.

Before going into details, let me summarise the main features of a British water mill. Water is channelled into an inlet stream. There is some type of sluice gate to control the flow rate. The water flows against paddles fixed around a large wheel, causing it to turn on a horizontal axle. This rotating motion is carried by a horizontal shaft to a crown and pinion gear which turns the motion through a right angle, onto a vertical shaft. This shaft turns the upper of the two mill stones, causing it to spin over the fixed lower stone. Grain is steadily fed into the small gap between the stones though chutes from a hopper above, and the flour from the crushed grains flows outwards along grooves in the mill stones to be collected in sacks. Within this general scheme there have been many variations to suit the water source, the amount of corn to be milled and the mechanical technology then available.

In the course of this study I came across material which gives snapshots of the lives of some of the people who lived or worked at Kepier in the 19th century. I mention some of these in the Appendix, §10, to show the mill in its context.

2 Some historical notes

2.1 The fire, 1870

Meade quotes in full ([2] page 49) the report of the Kepier mill fire in the Durham Chronicle of 30th September 1870. The event was reported in many newspapers around the country. Here is the complementary report from the Morpeth Herald, 1st October 1870:

> Destruction of Kepier Mill by Fire: About half-past two on Saturday morning intelligence reached the police station in Durham that a fire was raging at Kepier mill, and Superintendent Wilson, with a posse of police, immediately proceeded to the spot, but when they arrived with the engine, the flames were found to have got such a hold of the mill as rendered hopeless every effiort to save it. It appeared that the mill had been working over night, and Mr. Stonehouse was sleeping in an inner room of the place, while his son was left in charge of the millstones. He had fallen asleep, and the feeding spouts having become empty, the two stones grinding together, caused the sparks to fly about, and as there was plenty of inflammable articles near, it is supposed that some of those had caught fire. Mr. Stonehouse just escaped in time to save his life. The mill contained three large chambers, the whole of which were built of timber, and it may be expected, this blazed with a force which it was not in the power of man to subdue. The roof fell in with a fearful crash at about half-past three, and then the flames shot to a height that illuminated the country for miles round, and soon nothing but the bare walls remained. At seven o'clock one of the walls gave way and fell, several persons standing about having a narrow escape. Neither the property nor the stock (which included one hundred sacks of seed), were covered by insurance. Mr. Thwaites, we understand, will be a considerable loser, as the whole of the machinery belonged to him. It is said that Mr. Stonehouse's dog, not able to escape from the building, was burned to death. Mr. Walton, agent for Sir George Musgrave, the owner of the mill, visited Kepier, in the course of the morning.

The next day, being a Sunday, many Durham folk strolled out to gaze at the smouldering ruin.

Uncontrollable fires were not uncommon. In 1868, two years before the mill fire, there was another serious fire at Kepier in which a barn and stables to the north of the farmyard were completely destroyed [6]. The farm tenant, John Thwaites, lost two horses, a cow, a new gig and his stores of hay and straw in the blaze. Even in Durham City the Theatre Royal burnt down in 1869. There had also been a spectacular fire in 1804 which destroyed Salvin's cotton mill near St. Oswald's church, an event captured in paint by the artist Paul Sandby.

2.2 Mills at Kepier before 1800

The 18th century antiquarian John Cade has stated that masonry in the river bed just north of Kepier was the piers of an ancient bridge, seemingly of Roman construction and evidence of a Roman presence in Gilesgate [7]. The name 'Kepier' derives from the Middle English words 'kype' and 'weir', a kype or kipe being a wicker basket used for catching fish, so important to the mediaeval diet. Water flows faster on the outside of a bend so this position on the River Wear was also a sensible place to site a water-driven mill. Since bread has been the 'staff of life' for centuries, there has always been a need to grind the corn grown locally. We may conjecture, therefore, that people here were occupied with a fish trap and a primitive corn mill from very early times.

According to Meade, the Hospital of St. Giles was originally founded in 1112 at the top of Gilesgate bank. In 1118 the brethren were given stewardship of a corn mill on the Millburne in the

newly founded Framwellgate settlement [8]. This later became known as the Clock Mill. The Bishops Mill behind St. Nicholas church was probably also working at that time, supplying flour to the city centre. This first Hospital of St. Giles was burnt down in 1146 by the retainers of King Stephen during the civil war with Matilda, but was refounded at Kepier in 1180 by Bishop Hugh LePuiset, also called Pudsey. It is conceivable that wagon traffic to a mill and fish weir had established tracks both from the city and from fields and barns around, and so made Kepier waterside a fairly well prepared place to build the enlarged hospital; moreover, stone could readily be brought on a raft from the quarry about 2 km downstream. Whatever its ancient origins, a mill at or near the one in the photograph was built soon after the establishment of the hospital when Gilbert, chamberlain to the bishop, gave the brethren of Kepier Hospital the right to construct a dam across the Wear [9], as one of several endowments to the newly refounded institution. The dam would channel most of the river's flow into the mill and so greatly increase its power, though at the cost of impeding river traffic. The mill would serve not only the hospital, but be an important economic entity for the wider community. It would remain the manorial mill for Gilesgate for centuries. We know that in 1329 there was also a fulling mill there (used in the preparation of woollen cloth) because William the fuller was stabbed to death that January [10].

In 1545, at the dissolution of the monasteries in Henry VIII's reign, the estate passed to a secular land owner. The original estate was linked to the parish of St. Giles and extended north-east to Ramside and east to Old Durham. Hutchinson lists the transfers of ownership from Henry VIII to Sir William Paget, then the Cockburn family, then the Heath family, then in 1658 to Sir Ralph Cole. Cole's son Nicholas sold the estate in three parcels to the Musgrave, Carr and Tempest families. So Sir Christopher, 4th Baron Musgrave, came to own one portion of 130 acres in 1674, including the Kepier Hospital buildings. The Musgraves continued to live at Penrith; they managed their Durham estates as investments through a local land agent.

With lordship of an estate went the feudal 'soke' rights that all tenant farmers must grind their corn only at the lord's mill, and that for a fee. As late as 1726 John Tempest, the then owner of the manor of Gilesgate, was claiming that his tenants were obliged to grind corn at his mill. By that time, however, the locals were having none of it and organised opposition [11].

A document from 1675 in the Musgrave archive prompts us to ask 'Was there just the one corn mill at Kepier?'. A deed dated 23rd October 1675 between Sir Christopher Musgrave and Edward Hodshon, miller, of Kepyer[2] and John Pearson, miller, of Gilligate (Gilesgate), Durham, Sir Christopher leases to them '*three* water corn mills at Kepier and one fishlock belonging thereto'. This agreement for three mills and one fishlock was re-established on 17th September 1679, this time between Sir Christopher Musgrave and Edward Hodshon, 'millner, of Keepyer and John Banks, millner, of Keepyer'. The deed required the millers to repair the mills as needed and leave them as going concerns upon expiry of the lease. Clearly two tenant millers were running businesses at Kepier, perhaps from adjacent mills. In addition there was a new fulling mill, presumably taking power from the River Wear. In a deed dated December 1671 Sir Ralph Cole leases to Ralph Carr Esquire lands and buildings formerly part of the demesne lands of the dissolved hospital of Kepier, including "the Great Coal Field and the oxen layres, all in the occupation of John Forster; and a newly erected walk mill or fulling mill standing in the said oxen layres and part of the premises upon the River Wear occupied by Cuthbert Johnson and John Harrison, fullers"[12].

It seems likely that the machinery and enclosing building(s) of corn and fulling mills were

[2]There is no consistent spelling until the mid 19th century. We find Kypiyer, Kypier, Kepyer, Keepyer, Keepier and even Kippeyar.

modified over the centuries as technology advanced and demand increased. In the Musgrave papers is an bill paid to John Horne for work between August and November 1679 making new mill wheels. The next year, in March 1680, Sir Christopher contracted with Nicholas Palmer, a freemason of Elvet, Durham, for £20 for repair of 'the mill dam crossing over the River Wear at Keepyer between the fifth lock to the further landstaple on the other side of the river and the same landstaple'. There was a surveyor's assessment of the Kepier estate in 1757 when the mill tenant was Anthony Dobson. The comment is '(lease) Expires 1759. in exceeding bad repair'. We may assume it was in even worse condition after the massive floods of 1763 and November 1771, when bridges and houses in Durham City and indeed across all North East England were swept away. Figure 2, therefore, probably shows the mill at its most dilapidated.

There were other businesses being run alongside corn milling and fulling from the 17th century. In addition to farming is brick making, stone quarrying on the banks of River Wear in Kepier wood, and coal mining from drift and shallow workings. Thus the survey of 1757 comments on the land's quality: 'Brick Garth : Mostly spoild by the brick making. White Leazes: Exceedingly bad – Coals got in it'. At that time some of the coal was used by tenant John Bird to fire his lime kilns.

2.3 Rebuilding c1803

The changes from Figure 2 to Figure 1 give the strong impression that the mill was largely rebuilt and extended to a second floor. Additional pairs of grinding stones may have been added. Several mills in Britain had an extra water wheel and grinding stones added when improved farming methods produced larger grain harvests. Mill engineering made large advances after 1759 when the pioneer civil engineer John Smeaton FRS published his experiments to determine the best designs, and when cast and wrought iron replaced wood for much of the mill machinery.

As noted in §1, the closest evidence I found that the mill might have been rebuilt was in the letter dated 12th May 1804 from the Durham land agent which reads 'The Mill will be completed against the 12th May and is one of the convenient things in this Country. in my next (letter) I will send you a drawing of the building'. Perhaps this next letter it will turn up one day. Mention of a drawing suggests there was something notable about the new architecture.

Another letter from William Taylor to Baronet Musgrave gives further information on the mill a few months earlier, in 1803. The mill may have been untenanted during refurbishment, but the time had come to find a new tenant who would make good use of the enhanced facilities. The first half of this letter is about R. Renny, the mason leasing Kepier quarry, and about stone for a new bridge in Durham City. Taylor says in a later paragraph:

> Beamish Oct 19th 1803
> ..... I have had a regular Survey and Plan of Kypier made, and have sent You an Eye plan, that I may the better explain, what I now mean, to be done with Your Estate. You'll also receive two Bills & my Acct and a letter from Mr Starforth, which means nothing as there is no probability of his going forward in Trade.
>
> The Estimate I have made for letting the different parcells of Ground I should hope you'll think right for the Old Tenants to have an offer, I purpose taken the Greatest part of the Ground that has been lett with the Gardens, as an accommodation to the Person who may take the Mill; and I would recommend the Garden & Ground be lett by proposal, and a Term of 12 Yrs the Occupier providing Trees etc. a Ten(an)t can afford

to give a greater Rent by increasing the Term of Years. As to the Mill, I find from the present Lease You are entitled to all the Machinery, at the End of the Term, and is of considerable Value, being a Spinning machine for their large Manufactory unfortunately, and unexpected from the state of Messrs Surtees Burdon and Coy Bank in Newcastle, stoping paymt it causd a general alarm in the Country, and Messrs Starforths like many others have been float'g on Paper Currency, and are now declared Bankrupts, and a considerable deficiency in their Effects is expected; the Assignees feel much disappointed, that the Machinery becomes your property, the whole been under Mortgage to the Durham Bank; I propose that this Mill and Ground be advertised in the Newcastle Leeds papers, and shall ask for the Mill alone One Hundred and Twenty Pounds exclusive of the Land, and I am very sanguine in obtaining 100 a Year having so constant, and large a Stream of Water, makes it very Valuable for any kind of Manufactory – who ever becomes the Tenant will wish for a longer Lease than 9 Yrs, ...
Yr very Obn Hble Servt Wm Taylor

John Starforth owned and operated a large woollen weaving factory in the centre of Durham. He was the town's largest employer, but he went bankrupt in October 1803. Piecing this together, it seems that Kepier mill was in a dilapidated state in the 1790s, but a significant investment was made soon after 1800 to rebuild, extend and re-equip it so that the water power could drive a small factory. They therefore installed new corn grinding machinery and a wool spinning machine – perhaps one of Samuel Crompton's spinning mules – to make yarn which probably went straight to Starforth's weaving sheds. The spinning venture, however, was probably short lived after Starforth went bankrupt in a banking crash[3] during the financial instability of the Napoleonic Wars. With the mill rebuilding almost finished, the timing could not have been worse. A lease for the mill was taken by William Brown, but the newspapers in December 1809 reported that he too had followed Starforth into bankruptcy. Nevertheless, the mill's rebuilding was planned with confidence with a design to give the building some picturesque appeal to complement the fine gardens. The mid to late 18th century saw the Early Gothic Revival when romantic follies were built, displaying the land owner's ancient ancestry. It therefore seems likely that imposing gothic windows overlooking the river were added, making it 'one of the convenient (i.e. agreeable, becoming, befitting) things in this country'.

The evidence does not make it clear to what extent either the pre-1800 or the rebuilt mill building was also a dwelling. We do know from the newspapers' accounts of the fire that 'Young Stonehouse was left to work the mill while his father was sleeping in one of the apartments of the building'. (There is no mention of Mrs. Stonehouse or servants escaping – where were they?) The fulling mill in Durham City also had living accommodation. However, for many years the mill was let together with a dwelling house, a garden and 36 acres of farmland. Thus, in a deed of 1819 the tenant was Thomas Wilburn who leased 'that messuage or dwellinghouse ..... and all that water corn mill with the mill race and mill dam thereto belonging and all those five closes or parcels of ground containing together thirty six acres ... or thereabouts; together with the stable byre and other buildings stackyard and several other appurtenances except all the mines and quarries and woods'. Wilburn, therefore, was himself a fairly wealthy man, living in a house on the Kepier site, and he may have employed assistant millers to carry out the daily work. Similarly a newspaper advertisement placed by the agent John Smith of Beamish in October 1827 reads:

To be Let ..... All that Water Corn Mill, situate at Kepier ... There is a constant supply of water to this mill from the river Wear, and where business may be carried on to a

[3]The Surtees Burdon and Brandling bank in Newcastle-upon-Tyne failed on 30th June 1803. see 'The House of Common 1790-1820' by R G Thorne, 1986.

> considerable extent. The whole or part of 36 acres of rich productive Land ..... may be let with the same. There is a good dwelling-house, garden, and all necessary building upon the premises.

So was this dwelling house attached to the mill (literally 'upon the premises'), or was it somewhere else nearby?

Wilburn died in about 1830 and the tenant after him was Thomas Gibson, who remained until at least 1854. He too leased the mill and farmland, but also the inn. The census of 1851 and 1861 both record the miller and his family living just at 'Kepier', not 'Kepier Mill'. That there were sub-millers is attested by at least two newspaper reports. In 1864 Nicholas Oliver 'of Kepier Mill' was before magistrates for poaching salmon in the Wear. In August 1867 there is the tragic story that 'On Monday afternoon the son of *one of the millers* at Kepier Mills, Durham, was found drowned in the mill race' (my italics). On balance, I think the dwelling house was part of the mill building and that six or more people lived there at any time. It was quite grand when rebuilt in 1803, but probably became shabby when the prosperity of the mill declined after about 1840.

2.4 Regular repairs

On reading the workmen's invoice vouchers, the land agents' accounts and letters to Baronet Musgrave, one gains the impression that the mill dam and the riverside cart track from Durham were frequently breaking up and in need of repair. Repairs to the mill itself are mentioned less often. The most severe damage occurred whenever the Wear flooded. In some years the bill for timber, stone, carpenters and masons was large. These examples convey the picture:

- As early as 1690 we find 'The charge for the miln dam for the year ending 12th July £5 7s 4d. Labour and materials working 20 yards of stone.'
- In 1823 John and Thomas Greenwell were paid £1-2-0 for four loads of lime for repairs at the mill.
- In 1834 £30 was paid in compensation to J. Burlington 'in consequence of the floods of the river covering the grass land attached to the mill with sand.' At the same time Robert Wallace presented another carpenter's bill for £10-9-1 for repairs and 'spiling the river bank to preserve the road to the mill.'
- In November 1835 £43-10s was paid to Robert Wallace for 'carpenter's work in repairs of Kypier Mill dam'.
- In November 1837 Jervis Robinson, the agent, writes to Sir George

  > 'Herewith ... vouchers for repairs at the mill dam which I am sorry to say are heavy... At the time the repairs at the mill dam were going on the water was favourable for our purpose the Key (Quay) Wall was in a bad state. I have had stone put in where wanted and the whole pointed with lime in a good season. The dam is now I trust in good order. It might be much improved by adding to it what the workmen call an Apron but it is expensive being freestone pressed together by a wood frame work. In case you should consent to its being done, I should only advise a yards say 15 or 20 to be done in one summer'.

  The bill that six-month included £49-16-11 for 'freestone and other materials and mason work at the mill dam, Key Wall and general repairs' and included 100 tiles and 700 bricks, several carts of lime, and timber.

- In April 1840 Jervis Robinson paid another repair bill to Robert Walker for carpenter's work sloping and spiling the mill race, £21-6-6, plus £22-12-7 to T. L. Jackson, mason.

- In a letter to Sir George dated 15th December 1848, William Robinson (agent) states 'The masons and carpenters bills in the account were from the foundations of the mill giving way in consequence of being continually in water and I hope the mode we have used will quite secure the same for some time to come.'

- There was another damaging flood in 1854 and the next year £244 was spent on repairs. Then in 1856 the Durham agent, Thomas Storey, wrote to the Musgraves's Penrith agent, Lancelot Dixon, to explain a four-stage programme of repair, ending 'The conclusion thus come to is that £550 is yet wanted to finish the Dam and Mill Race; If no floods damage the works unforeseen contingencies occur and the present Dam is not further injured'.

- On 15th November 1858 the Durham agent Thomas Storey wrote:

  > When at Kepier the other day I examined the wharf wall protecting the cart road near to Kepier Mill; altho I feel reluctant to urge on your attention the immediate necessity of making some repairs to protect the river making some inroads of that Quay Wall to maintain the only road to the mill, two farms and public garden. From my examination it appeared to require about 20 Piles with some rough slabs as backing ..... I must ask your immediate permission to make the repairs or we shall soon have the cart road partly destroyed and access cut off to the farms and mill.

- However, only the next year, in March 1859, John Wallace invoiced Sir George £25-14-9$\frac{1}{2}$ for repairs to the mill dam.

The receipts for repairs of the dam and road often refer to 'spiling'. This was a method for limiting river bank erosion, similar to hedging. Wooden spiles (live stakes) were driven into the ground at the water's edge and live saplings, usually willow, woven between them. This wicker fence was then back-filled with soil. The spiles took root as did the woven saplings and the root mass bound the bank.

2.5 Waning importance

With these regular heavy repair bills it is not surprising that by the mid 1850s the viability of the mill was being seriously questioned. In a letter dated 13 May 1856 Thomas Storey replies to the agent at Penrith that

> I have your letter of 10th Inst saying that Sir George is desirous of information respecting the Kepier Mill; to which I would reply that the Rent of the mill when held separate, or by itself, was £60-0-0 per annum . It is a serious Question to answer: the abandonment of the mill. In one of my letters to Sir George I ventured to him that such property was very precarious and in many instances would not pay common interest on capital and repairs. I do believe that Kepier Mill is of this description, having got into such bad repair, that such expense must swallow up the Rent of the Mill for 10 or a dozen years... The wheel is in bad repair. I have asked a millwright what the cost would be to put it in tolerable working condition. Were the property my own ... and I was called on to expend £1000 on its repairs besides doing something annually to keep the dam wheel trough and water wheel in order, on so treacherous a foundation, I would abandon both the mill and dam.

In the same vein, in two letters dated 14th and 16th May 1856 the Musgrave's solicitor William Bleaymire advises Sir George that 'Mills are certainly a most unsatisfactory kind of property. They are always requiring something to be done to or about them, and in this instance the rent it is let for is only Interest... '

There are a few further notes about Kepier mill cited in the thesis by D. A. Kirby, 1969 [8]. He quotes House of Commons Sessional Papers HC XXVIII 77, 1863 that by the 1850s Kepier mill was still working but 'old, insignificant and expensive to repair ... its function could more efficiently be done by a steam flour mill'. After the repeal of the protectionist Corn Laws in 1846, there was a large increase in the quantity of grain imported from North America, conveyed through the rapidly growing railway network; Durham goods station, close to Kepier, was opened in 1844. The 1857/61 six inch series Ordnance Survey map Durham XXVII shows a steam driven corn mill near the railway viaduct in North Road and another corn mill at Gilesgate Moor, also probably steam driven using coal from the small local mines. Kirby points out that by about 1860 Durham had largely ceased to be a wheat growing county. There was a drop in food prices from about 1870 and those mills which remained by that time turned to milling only coarse animal feeds rather than fine bread flour. By 1870, therefore, Kepier mill was obsolete and approaching the end of its days, and the fire merely brought forwards the inevitable

We should not see the mill just as an example of industrial archaeology. It was a work place surrounded by people carrying out other businesses. The Appendix, §10, gives some snapshots of life at Kepier in the 19th century.

3 Geography and ground plan

Some old maps give an impression of the rebuilt mill, after 1800 [13]. Figure 3 is a detail of the tithe map of the parish of St. Giles, Durham, dated 1845. Figure 4 is drawn from Ordnance Survey (OS) maps surveyed of 1857 and 1894. It is frustrating that the mill building lies exactly in the edge of two map sheets, so the drawing is made by joining sheets to the south and north. Figure 5 is drawn from the OS map revised in 1895, surveyed after the mill had burnt down. Let us take these maps in date order.

The 1845 tithe map shows the mill as an almost rectangular building over the mill race. There is a shallow angle in the line of the eastern wall, facing the barn, and the north and south end walls are not parallel. Perhaps this indicates two sections to the building. The mill is drawn about as long as the north face of Heath House, which was 44 feet[4]; that is, the mill is shown as about 45 feet by 20 feet. There is a small structure at the south-east corner for the mill; could this have been a privy for the convenience of the millers and visiting carters? Two island banks of earth are shown in the river, one alongside the mill and extending upstream, the other downstream. Together they form part of the dam and tail race. These may have been natural rather than man-made. The thin line indicates the rest of the weir extending to the west bank.

In Figure 4 (1857 to 1894) note these features:

1. the L-shape of the mill ground plan, only one section of which is over the race. This section is at an angle to the race, creating a pointed corner at the south-east. The angle inside the building at this corner would be about 60°.

[4] 1 foot = 0 · 3048 m, 1 m = 3 · 281 feet.

Figure 3: Detail from tithe map of St. Giles parish, 1845.

2. the downstream elongated bank of ground lying parallel to the eastern river bank, extending about 180 feet (55 m) and forming one side of the tail race,

3. the weir on the south (upstream) side, crossing to the west bank. Some stones and wooden piles near this bank can be seen in Figure 1.

4. the positions from which the Hutchinson drawing and the Frith and Gibby photographs were taken. (I explain in §4 how I determined these.)

By measuring the L-shaped ground plan and knowing the size of adjacent buildings which still exist, I estimate that the mill was about between 20 and 30 feet (6 to 9 m) from west to east and between 40 and 50 feet long (12 to 15 m), north to south. The length is consistent with the tithe map, but the shape is different. If the tithe map gives an accurate ground plan, it seems that the mill was modified between 1845 and 1862, though this may just have involved demolition of a lean-to shed roof over the mill wheel and tail race.

The notable features of the later map in Figure 5 are

1. the building again is shown in plan as a quadrilateral, not an L-shape, but the 60° angled SE corner is retained,

2. the mill race has disappeared, already silted up. The re-entrant pool at the south end of the earth bank is there today.

3. the earth bank upstream of the mill is shown with two lines of small rectangles, the nature of which is not stated. I propose that these are stone paving blocks set into the earth bank forming a reinforced part of the weir and head race (see Figure 10) – perhaps the 'apron' recommended in 1837 (see $ 2.4).

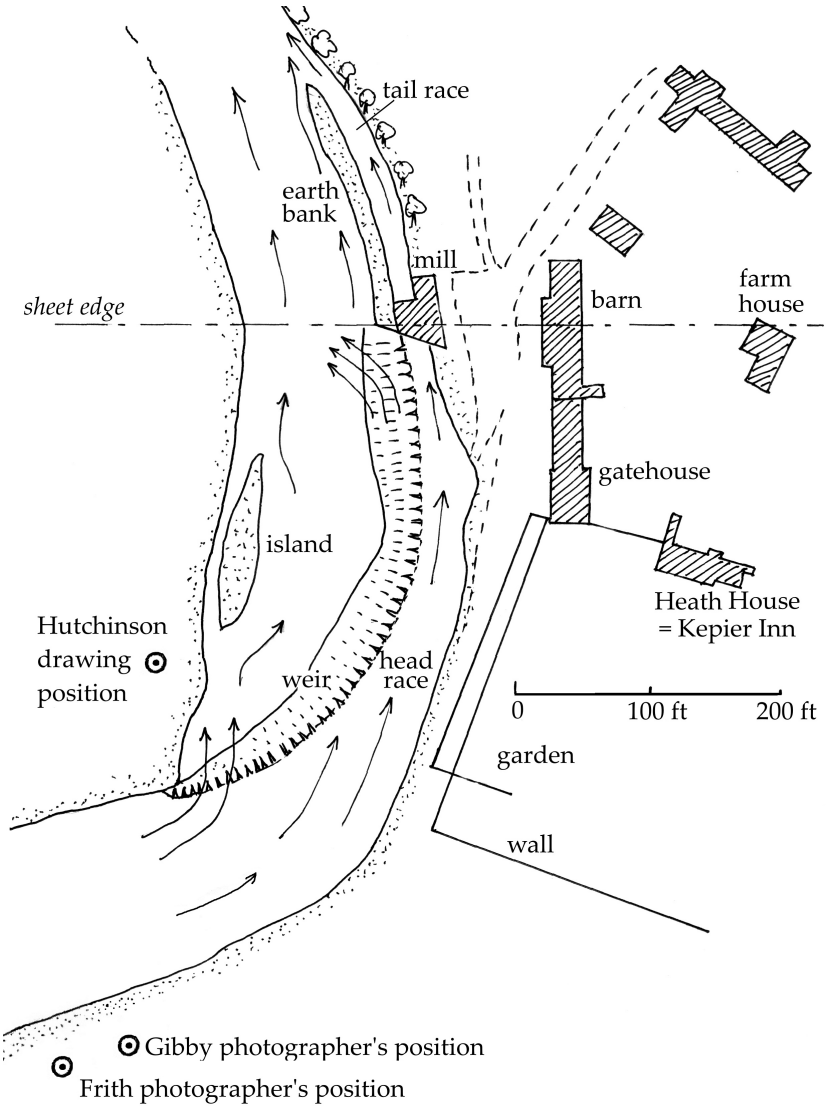

Figure 4: Plan drawn from OS maps of 1857 and 1894. The flow lines in the river are taken from the earlier map. Heath House by this time had become the White Bear Gardens Inn.

D. A. Kirby reports in his 1969 thesis [8] the results of measurements of flow rates in the River Wear recorded at the Abbey mill opposite Durham cathedral. What is striking is the vast increase in flow rates on some days when there has been heavy rain or melting snows. In summer the typical rate is about 50 million gallons per day (mgd) or about 90 cubic feet per second, $2 \cdot 6$ m^3/s. The dam would need to capture much of the flow for the mill to operate in dry weather. From autumn, when demand for grinding wheat would be highest, the typical flow rate doubles to about 100 mgd (170 to 200 cubic ft/sec). In winter and early spring, however, the rate could be 4 or even 8 times higher on a few days of flash floods. The dam might be swept away at these times, whilst the mill building would need to withstand the sudden increase in water level and the debris of leaves and broken branches carried downstream. Indeed, it was usual for water mills to have some simple equipment to screen out debris. This might be an iron grid placed across the incoming stream. Another system was similar to a U-bend; boards were placed across the stream at water level to skim the water surface and hold back floating debris, but allowing flow underneath the boards. The only

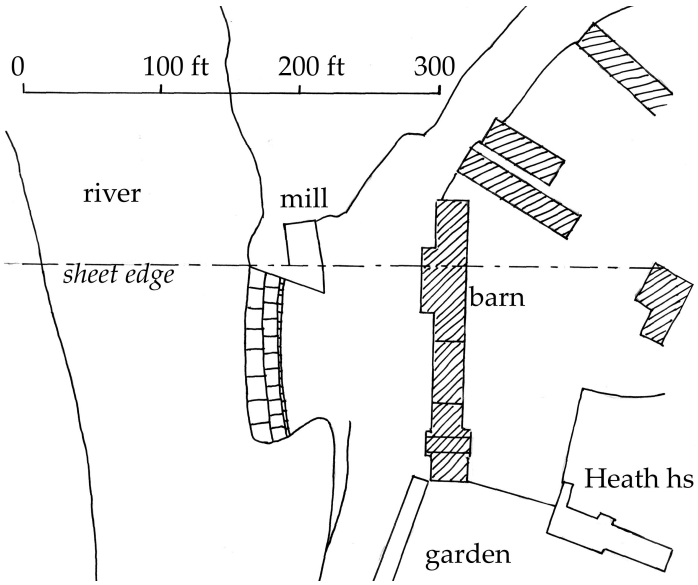

Figure 5: Map drawn from two OS 25 inch (1:2500) series maps of 1896, surveyed after the mill had burned down and Heath House demolished. The mill race has all but disappeared, leaving only a re-entrant pocket of near-stagnant water, which is still there.

specific evidence of a debris filter at Kepier is the bars across the arch opening in the Hutchinson drawing. However, if the southern mill wall were angled at 60° or 70° to the water flow, as the maps show, the current would gradually wash debris over the weir into the main course of the river, making this side of the mill crudely self-cleaning.

4 Old drawing and photographs

The brush and wash picture in the Hutchinson book, Figure 2, shows the mill and dam from the west bank of the river. It is not particularly well drawn, and the perspective on Heath House is poor. The mill building looks to be single storey, perhaps 30 feet long, 10 feet above ground level at its entrance. The water inlet archway has a grid over it to prevent debris entering, and the wall above the grid, perhaps 10 feet high, appears broken at its top, as if it were the remains of an earlier mill structure. The main part of the building seems to be built behind this archway wall, not attached to it, since what looks like the branch of a tree overhangs the archway wall. A small wing, with its own pitched roof and gable against the river, projects at right angles from the main building. There is no sign of the water wheel. The long island of earth which forms part of the dam is overgrown with grass, and in the pool below the dam the water is still so we see clear reflections.

The left image in Figure 6 is an enlargement of the mill ruin in the Frith postcard, and the right image is the same from the Gibby photograph. There is one other old photograph, shown to me by Michael Richardson, but its quality is very poor. All were taken from the south-east riverside track from Durham. The Gibby image is a morning picture with the sun casting shadows from the right. In all three the mill arch, the edge of the east wall and central window opening are clear, but the rest is difficult to make out. The reader might care to stare at Figure 6 then sketch where the walls and other windows were. The high section of wall nearest the barn is consistent with a ground and first floor. It is not possible to see whether it is all made of stone or whether some is brick. There is a demarcation about half way up the facing wall which may indicate a ledge or a change in texture

of the masonry. This probably corresponds with the low front wall in Hutchinson's drawing. In the middle of the image the top of the wall slopes at about 40 degrees downwards towards the river, such as might have supported a sloping roof. To the left of each image are three window openings, seemingly with gothic-style arches similar to those in the gatehouse. Immediately above these the wall is horizontal. To the very left of both photos might be a broken low wall by the river. Was this a separate structure not shown in the maps, or was it a section of the building that had tumbled down from the first floor, landed upright and somehow remained largely intact? In front of the mill on the river side is the up-stream earth bank. In the bottom left of the photographs are some wooden stakes and rails forming a fence-like structure with stone infill, which was a section of the mill dam. To the left of this, adjoining the western river bank, is a length of brick or stone wall.

By careful measurement of these two photographs it is possible to recover some information about the size and shape of the mill building. I have made two sets of measurements, one to determine the height of the ruin, and the other to glean something about its width and depth. In both cases measurements were made on enlarged digital images on a computer screen using horizontal and vertical cursors reading in pixels. Pixel measurements were converted to real world measurements in feet or metres by comparison with structures such as Heath House whose dimensions are known.

It is first necessary to determine where the Frith and Gibby photographers were standing. I did this by selecting about ten features in each photograph which still exist. From a present day aerial map (on Google Maps) I determined the east and north position as (x, y) co-ordinates of each feature, and then measured the position of its image across the photograph. The selected features included the corners of the barn, gatehouse and Heath House and the two chimneys on the farmhouse. Using some basic co-ordinate geometry it has been straightforward to trace the ray from each selected feature on the map to a postulated position of the camera, and hence determine where this ray would cut the plane of the photographic plate. The true camera position is the one which gives a best over all fit of these ray points in the picture plane to the actual images of these features

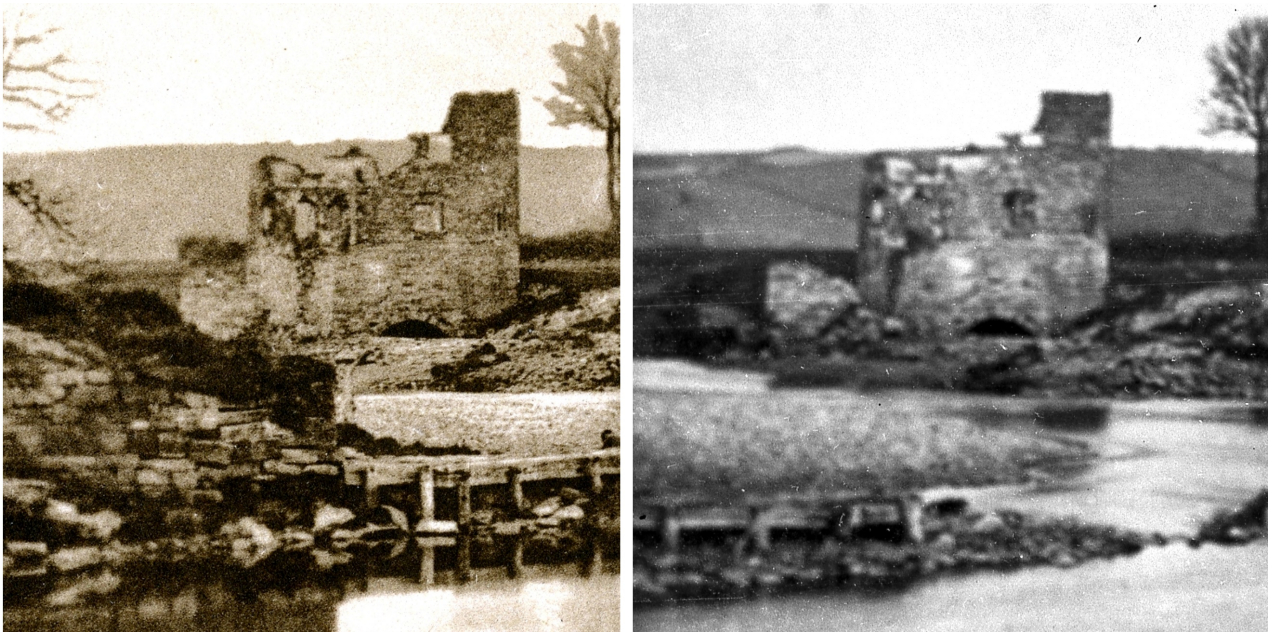

Figure 6: Two of the three surviving photographs of the ruined mill. Left: detail of Frith postcard in Figure 1. Right: Gibby image K1.

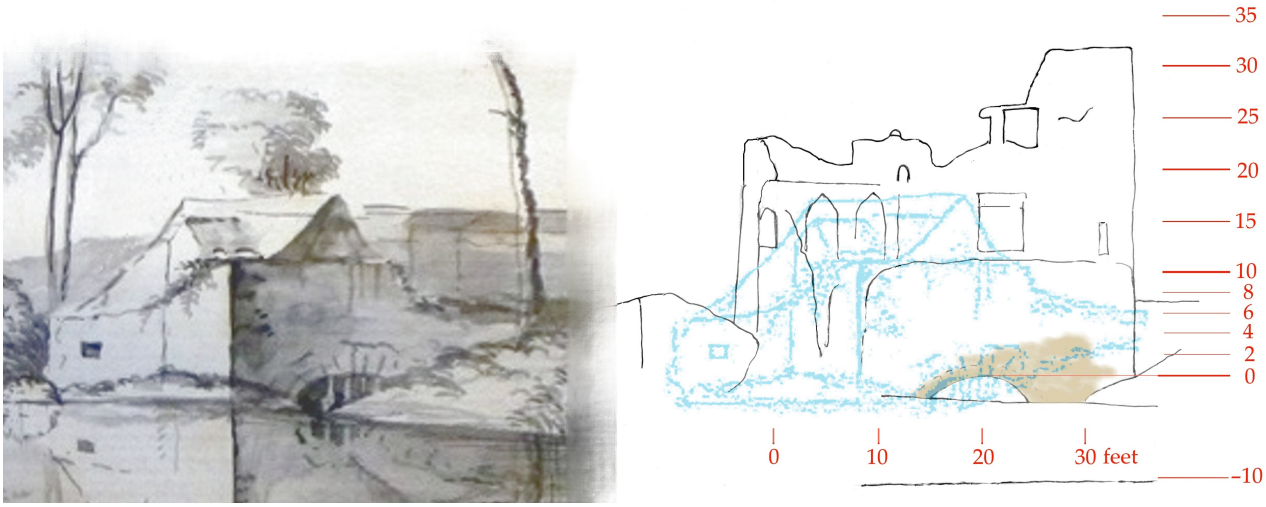

Figure 7: Left: Hutchinson drawing scaled in width to simulate appearance from position of Frith photographer. Right: Tracing from Frith photograph with scale measuring height in feet above the top of the arch opening. Stone-coloured patch shows remaining stonework.

in the photograph. I determined the best fit in a least squares sense using the Solver facility of the Microsoft Excel spreadsheet. The Frith and Gibby photographers stood on the cart track in front of today's Orchard Drive. Gibby stood about 50 feet (15 metres) closer to Kepier than did Frith. The mill and Heath House were the same distance from the Frith photographer.

The height measurements were made by comparison with Heath House, whose dimensions are known from the existing ruins and from the careful scale drawing by W. G. Footit (figure 21 in Meade's monograph, taken from Gibby archive K14b). The main body of Heath House was $44 \cdot 5$ feet long, 25 wide, and 27 feet in height from the top of the loggia arch openings to the eaves. From these I determine that, as the mill and house were at the same range from Frith's camera, the height of the mill from top of the arch opening to the highest point of the ruin, which I take to be the eaves, would have been about $31 \cdot 5$ feet. Equivalent measurements on the Gibby photograph, scaled to allow for the slightly longer distance to the mill, give the arch-to-top height as $32 \cdot 2$ feet. Let us therefore take the value to be 32 feet. This scale is marked on the right panel of Figure 7, where the black lines are traced from the Frith photograph. The coloured patch around the archway denotes all that remains today. The left panel of Figure 7 is the mill in the Hutchinson drawing, scaled in width to simulate how it might appear from the position of the Frith photographer[5]. The ghostly pale blue image superimposed on the right panel of Figure 7 is the outline of Hutchinson's mill on what I reckon to be the same scale. You see that I have identified the top of the archway wall in the Hutchinson drawing with the change in texture of the stonework in the Frith and Gibby photographs.

The horizontal top of wall above the three gothic windows may mark the ceiling of the ground floor[6] rooms. The height of this above the mill arch is almost 19 feet. This would make the upper storey about 13 feet high. The eaves were $24 \cdot 5$ feet above the road where the carts came, the same height as the north and south wings of the gatehouse. These are lofty dimensions. By the same method the visible sector of the mill arch is 9 feet wide. It is clear that this was not a small building.

[5] The Frith and Hutchinson pictures are from positions about 14° apart, subtended at the mill. The lengths of walls parallel to the river have been scaled in width to $\sin 31° / \sin 45° = 0 \cdot 73$, and the other sides stretched appropriately.

[6] Ground level here means the road level on the east side.

Using the same perspective, the height of the upstream earth mound above river level is no more than 6 feet. The height above water level of the wooden planks in the weir is about $3 \cdot 5$ feet (just over 1m). Given that the river bed is higher upstream than downstream, we can estimate that the head of water at the mill was between about 4 and 5 feet.

In my second type of measurement on the three old photographs, I used the positions of the three photographers and the positions of one selected feature of the mill ruin at a time, and reversed the calculation to determine where the lines of sight from the two cameras to that feature would intersect. This is a basic form of stereo-photogrammetry, a well establish surveying technique. Unfortunately, the Gibby photograph is so blurred that less than a dozen features can be precisely identified in both it and the Frith photograph. The Richardson photograph is even poorer. Moreover, the three camera positions were so close to each other that the parallax is small, making the determination of range uncertain. Range errors are about ±10 feet. All that I can reasonably state is that:

- the length of the building parallel to the barn is indicated to be about 40 to 50 feet, consistent with the 45 feet or so estimated from the maps.
- certain features are shown to be in the near (south) wall of the building and some in the far (north). I have taken account of these in the reconstruction in §7.
- the range measurements from combining the Frith and Gibby pictures were too inaccurate to confirm the 30° angle of the south wall. However, the six points from Richardson+Gibby combination, having greater separation, did give some evidence of this wall being at an angle.

5 Site examination

I visited the site in October 2016 and again in February 2017 when the vegetation had died back. The mill race has completed disappeared, being silted up and overgrown. The opening in the inlet arch is now 8 feet wide. Figure 8 shows that the stones are regular and cut to a good standard. On looking with a lamp into the archway I saw that it is in fact a tunnel at least 8 feet long, with a vaulted stone roof in good condition. The stones are laid along the direction of water flow (the axial direction). The left panel of Figure 9 is a photograph looking into the silted up tunnel. The front wall containing the arch is at 70° to the tunnel axis as measured from a photograph. The right panel of Figure 9 is a sketched ground plan, showing that it is just possible to make out square-cut stone blocks forming the footings of a second wall B which extended about $9\frac{1}{2}$ feet (3m) downstream from the end of the archway wall, plus a third wall C at right angles to it. It seems likely that excavations of wall C would uncover the roof or end of the arched tunnel. This implies that the water wheel was positioned just downstream of wall C. Walls A, B, C might correspond with the small 90° wing of the mill in the Hutchinson drawing.

The earth mound upstream of the arch is paved with large stone cobbles, a sample of which is shown in Figure 10. (The image contrast has been enhanced in the foreground.) I identify these with the array of small rectangles in the 1896 OS map, Figure 5. There are two parallel decayed and broken lengths of wood about 3 feet (1 m) apart, with stone block paving between them, jutting over the river's edge a few metres upstream of the arch. Perhaps they were part of a track, or a landing stage for grain or stone from Kepier quarry, or coal from the drift mine a mile or so further downstream.

Figure 8: The silted up mill arch in February 2017. The wooden stick is 68 inches (172 cm) long.

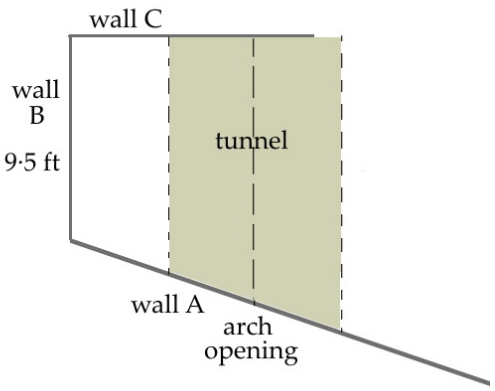

Figure 9: Left: Stone roof, looking into the arch. Right: Sketch plan of remaining stonework.

There is some demolition debris on the steep river bank on the upstream side of the mill ruin. I found old bricks and bits of orange-coloured tiles. If these do come from the mill, they point to it having had some brickwork, probably in the upper storey, and a tiled roof. Just behind the farm buildings there is still the remains of an early brick and tile kiln, and the other buildings at Kepier were tiled. Heath House was of brick on a stone base with stone quoins, window lintels, sills and mullions.

Figure 10: Large cobble stones set in the earth bank upstream of the arch. They slope gently towards the river at an angle measured as 11°.

6 Typical mill construction and operation

Water mills deliver power to the machinery through converting the potential energy in the water as it falls from a higher to a lower level. The difference in level is called the 'head' and the power delivered is given by the product: power = water flow rate × head × efficiency (in appropriate units). Three designs were in common use – overshot, breastshot, undershot – depending on the head. In breastshot mills the water enters at about the level of the axle, and in undershot ones it enters at a lower level. The measurements on Figure 1 show that the head at Kepier may have been only 4 feet. This is in the range of an undershot wheel, or a rather low breastshot one. The operating principle of this type is illustrated in Figure 11, taken from an 1899 German textbook on mill wheel design by W. Müller [14]. In a well constructed mill the stonework under the wheel is curved to keep the water in the compartments between the blades until they reach the lowest position. According Dr. Gerald Müller, a well designed undershot and breastshot wheel can be up to 70% efficient. To give an indication of power, if the Wear were flowing at 4 cubic metres per second, and the dam collected a third of this, and if the head were $1 \cdot 5$ m and the wheel and gearing 60% efficient, the power would be about 12 kW or 16 horsepower.

According to Kirby the mediaeval mill dam was essentially a wooden box framework filled with stone and caulked with packed moss. Each year the moss had to be repacked to limit leaks. Where the dam joined the river bank, strengthening was needed and a stone or brick wall was usually constructed. Kirby reports (page 54) that as late as 1860 the dam at Kepier was reconstructed in this ancient manner even though stone dams had by that time become the norm. All these features can be discerned in Figure 1.

The water wheel was probably outside the main building, and been 8 or 9 feet wide to fit closely into the measured width of the visible opening. If the water head was 4 feet, the wheel would

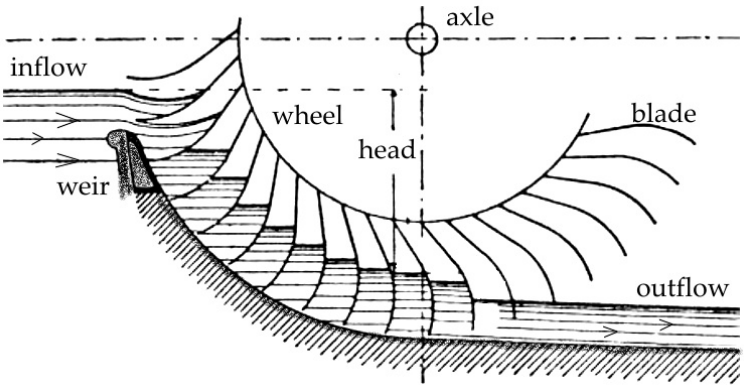

Figure 11: Section through an undershot mill showing how the blades and curved stone under-surface trap the water in compartments which fall as the mill turns. (after W. Müller).

be at least 8 feet diameter to the ends of the blades, and possibly 12 or 14 (about 3 metres). There would have been be a sluice gate to control the flow, probably just in front of the wheel. It would have been opened and closed with a rack and pinion gear.

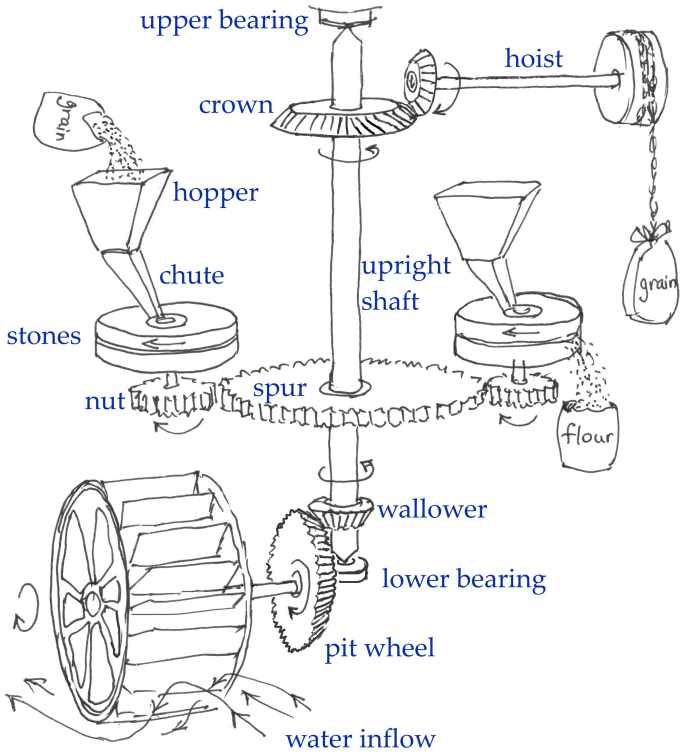

Figure 12: Diagram of typical water mill machinery for driving two pairs of mill stones.

I will only outline typical mill machinery since there is much on this subject on the internet. Figure 12 is a sketch of a typical arrangement. The horizontal axle of the water wheel would turn a large pit gear wheel, so called because it was in a pit below ground level. In a crown and pinion arrangement this drove a smaller 'wallower' gear mounted on the main vertical shaft. Figure 13 is a photograph of the iron pit wheel connecting with iron wallower on the oak upright shaft at Stretton

water mill in Cheshire. If the mill had only one mill stone, this shaft would turn the upper runner stone directly. If there were two pairs of stones, as at Stretton, a large diameter 'great spur' wheel was mounted on the vertical shaft and the drive to the runner stones taken via small gear wheels ('stone nuts') at the circumference of the spur wheel. The spur and one of the stone nuts can be seen at the top of Figure 13. The gearing greatly increased the turning speed; for instance, if the water wheel turned at 5 revolutions per minute, the grinding stone might turn at 100 rpm. The upright shaft continued up to the second floor where other gears and belts carried motion to auxiliary machinery, including a hoist for lifting sacks of grain from the ground floor. Figure 14 shows the wooden crown and pinion gears at Stretton mill, taking motion to the hoist.

Figure 13: The pit wheel, wallower, upright shaft, great spur wheel and one of the stone nut gears at Stretton water mill, Malpas, Cheshire.

Each pair of stones was encased in a wooden box to contain the flour, and mounted on a sturdy wooden frame raised well above floor level – raised so that flour could fall into sacks. Being such a large building, Kepier mill probably had two or three pairs of stones, typically 5 feet diameter. One pair might be set close together to produce bread flour, and the others further apart for coarse animal feed. The bread flour, however, would seem coarse to us. The initial grain was probably not cleaned and the final flour not sieved for bran and chaff – it was all just 'run of the mill'. Dressing the stones as they wore and maintaining the gears, shafts and related machinery was the job of a skilled millwright.

We can picture the carts arriving with sacks of grain and leaving loaded with sacks of flour. In some mills the lifting beam and sack hoist were inside the building, so the grain sacks had to be man handled into the building and pulled up through trap doors. Other mills had an outside loading bay with lifting beam cantilevered out from the top storey. A rope or chain would be lowered, a sack tied on and hoisted up to the top floor. The grain might be stored for a short while then poured into a hopper with a chute below feeding into the mill stones on the floor beneath. The flour would be collected in sacks and probably stored on the ground floor, awaiting collection by a cart which

backed up to the doorway. One of the skills the miller needed was to control starting of the mill. The gear train would be disengaged so that only the water wheel and pit wheel would start first as the sluice was opened. Then, when the water wheel was turning slowly, a gear (perhaps the wallower) would be moved by a screw adjustment to engage with the gears of the pit wheel and connect the turning motion to the vertical shaft and so spin the upper mill stones. If this was done too abruptly, the jolt would shear off the wooden gear teeth. Another skill was to set and maintain correctly the very small separation of the millstone pair for the grade of flour. The noise and vibration would have been substantial, and the whole place dusty with flour – hence the traditional nickname 'Dusty' Miller. With so much rotating machinery and ladders to climb, it would have been a hazardous place to work. In winter it would be cold and dark. All year round it would have been be overrun with mice, if it were not for the cats.

Figure 14: Wooden peg teeth in the crown and pinion gears at the top of the upright shaft at Stretton water mill, Cheshire.

7 Mesh model

I have tried to consolidate the scraps of information we have on Kepier mill by making a computer model of what it may have looked like in the 1850s. The result is essentially a computer 'Lego' model of the mill buildings, capable of being rotated in 3D on the screen and hence viewed from any direction. The software has the facility to hide selected components so that, for instance, a wall can be made invisible so we can see inside the building. I used a finite element analysis program called Mecway (www.mecway.com) usually used by structural engineers to calculate stress and deflection in loaded bridges, etc. The model is made by forming single brick-like elements and stacking them together into walls, beams, wheels, etc. In these images the faint lines delineate 1 foot cubes. The Mecway software allows colours to be chosen for the various parts of the structure, but does not apply realistic brick or stone textures or lighting conditions. In Figures 15 and 16 are four views of the basic mesh model. The ground level is shown together with sections of wall below ground. I augmented this by using the Blender 3-D graphics program (www.blender.org) to add masonry textures and from this produced Figure 17.

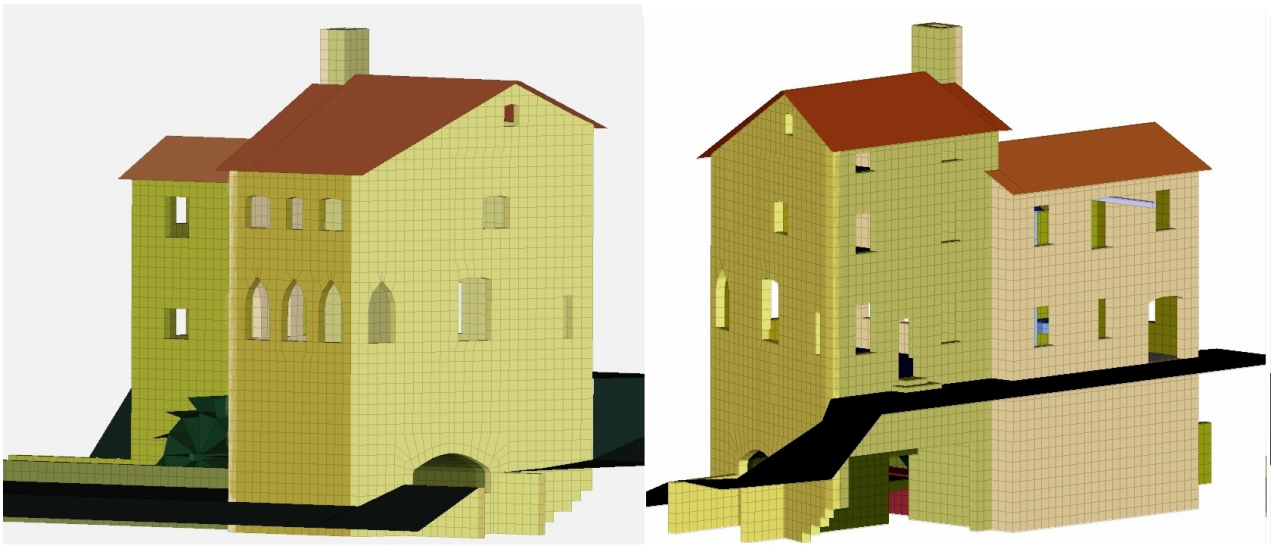

Figure 15: Left: View of mesh model from SW. Right: from SE.

I have struggled to make the model consistent with the photographs, the maps, the form of typical mill machinery, and with the way a stone and wood building would be constructed. I assume that the L-shaped ground plans indicate two buildings joined together, one the mill, the other the miller's 'dwelling house'. The more northern part must be the mill because the water wheel must lie in the race beyond the archway and tunnel. The southern wall of the house is at 70° to its eastern wall. The house has four storeys – cellar, ground, first and attic. I have made the ground floor rather implausibly high to accommodate the gothic windows, which go all round the west (river side) wall of the mill. There are no windows below the level of the ground at the doorways because any such window would let in river water at flood times.

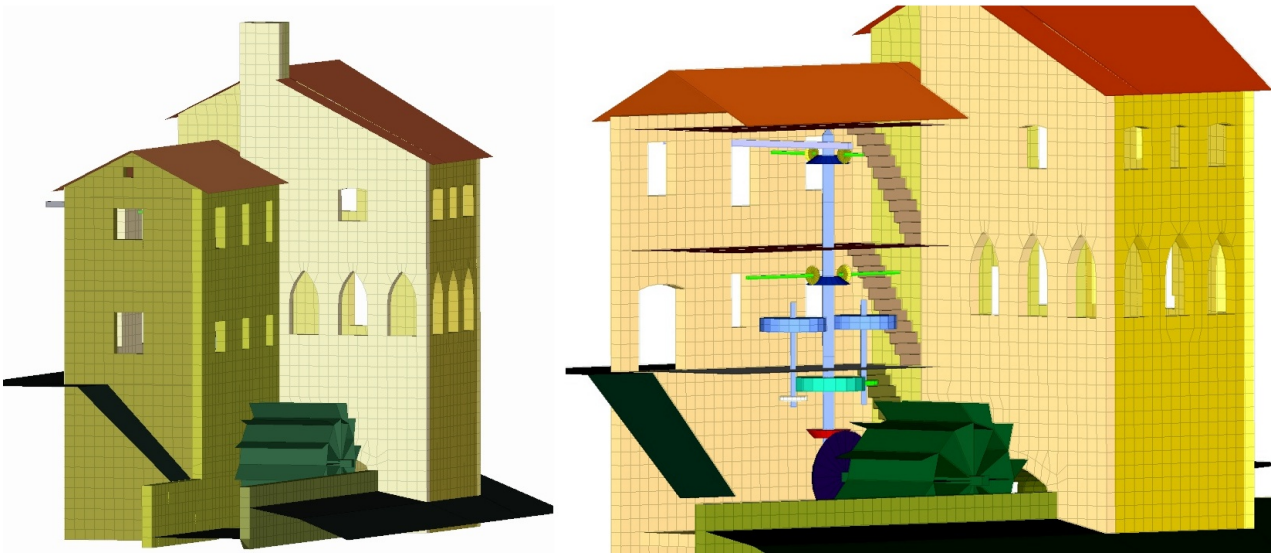

Figure 16: Left: View from north west. Right: cut-away showing mill machinery.

The water wheel, pit wheel and wallower, and spur and mill nut gears are in a cellar-level

Figure 17: Mesh model augmented by adding textures and a background to represent the mill as conjectured in the early 19th century. The diagram is cut away at water level.

room set into the steep river bank. I have taken the walls of this lower level to be made of stone blocks as in Figure 8, and the higher parts of rougher stones as with the gatehouse. The rooves are tiled. The height from top of mill arch to eaves is 32 feet, and the water wheel is 9 feet wide, 12 feet diameter. I suppose that the top floor of the mill was used for additional grain and equipment storage, and that the wool spinning machine was installed up there too, perhaps in a partitioned-off room. In the right panel of Figure 16 the nearer walls have been cut way to show the floors, stairways and milling machinery, in keeping with Figure 12, 13 and 14. The right panels of Figure 15 and 16 show a second hoist on the top floor working with an external cantilever beam and a loading door so that sacks of grain could be lifted straight from a cart direct to a hopper.

Some aspects remain problematic. The newspaper account of the fire quoted in §2.1 states that 'the mill contained three large chambers' built of timber; can we say that my model meets this description? Another puzzle has been the low wall to the left (west) of the photographs. What was this? No such wall is marked on any of the maps. After considering the options I have concluded that this was a large chunk of masonry which fell from the upper floor and remained largely intact. I have not modelled it. Another puzzle is why the chimney has disappeared. There would have been a fireplace and cooking stove in the house and perhaps a hearth in the mill too. The box structure of a chimney is strong, so it is surprising that it did not withstand the fire.

Having made the model I simulated the destruction wrought by the fire of 1870. This was done simply by deleting selected mesh elements until the ruin looked like the photographs. Figure 18 places the model ruin alongside the Frith photograph. Personally I feel that the agreement is good enough for me to complete my painting – Figure 19.

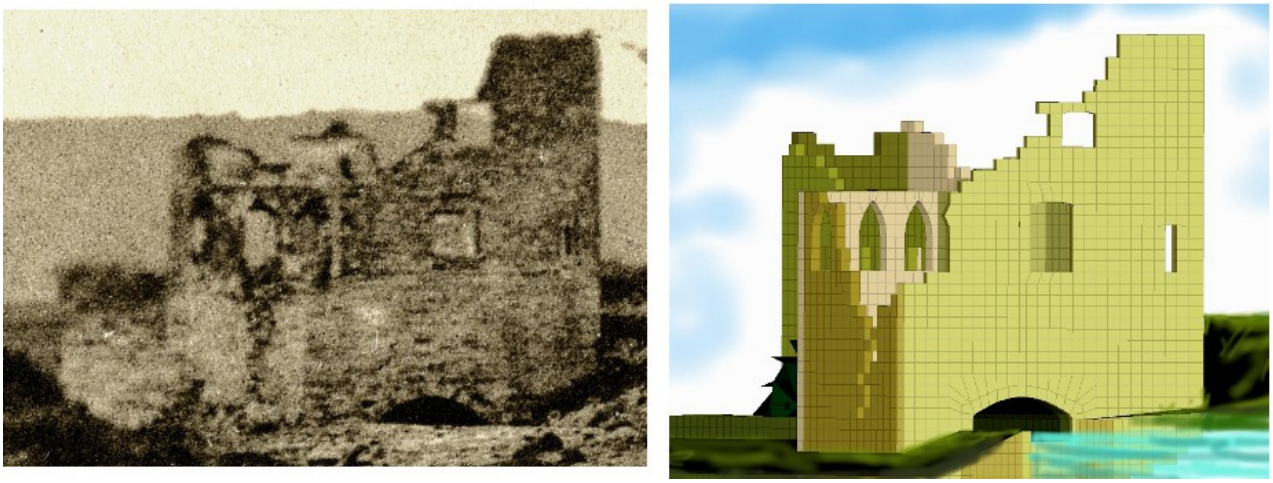

Figure 18: Comparison of ruined mill from mesh model with the Frith photograph.

Figure 19: Painting by the author based on the Frith and Gibby photographs of about 1880.

8 References

I obtained almost all the other sources, except the Hutchinson drawing and Dorothy Meade's short book on Kepier Hospital, via the internet. Many images in her book are now on the internet.

1. Durham County Record Office – Image DR00836, a Frith postcard showing Kepier Hospital in 1886, published 1902.

2. 'Kepier Hospital' by Dorothy M. Meade, publ. Turnstone Ventures, Durham, 1995. ISBN 0-946105-10-3.

3. Durham University library special collections. Kepier farm, inn and mill in photographic

collection of Dr.C. W. Gibby, image K1. Undated.

4. The drawing is inserted at page 299 of volume 2 of William Hutchinson's (1732-1814) own copy of 'The History and Antiquities of the County Palatine of Durham' in Durham Cathedral Library, stored at the University of Durham Palace Green Library, shelfmark Sel. 13.

5. It seems that the Musgrave papers were split up and sold off in lots. The part of the Musgrave archive at Carlisle is stored in two sets of boxes: CBME 7-10 and D/MUS/5/11/105 to 111. We examined the CBME set, mainly vouchers, but found they that relate only to the Musgrave estates in Cumberland and Westmorland. Papers on the Musgrave's County Durham lands are in the D/MUS/5 boxes which were uncatalogued at the time. Most of the information given in §2 and the Appendix comes from boxes 105 and 106.

6. This farm fire is reported in the Durham Chronicle of Friday 7th August 1868. All newspaper accounts, especially those in the Appendix, are taken from The British Newspaper Archive at www.britishnewspaperarchive.co.uk. Many stories were reported in several papers and I consulted over 100 articles, too many to reference individually.

7. John Cade 'Conjectures concerning some undescribed Roman Roads and other Antiquities in the County of Durham', *Archaeologia*, Vol 7, p 78, (1785).

8. Background information of the history of Kepier can be found in Meade [2] and in a) Hutchinson's 'History and Antiquities' Volume 2 which from p299 describes the parish of St. Giles, Durham. b) The Ph.D. thesis of D. A. Kirby, 1969, entitled 'Some physical and economic aspects of water use in the Wear basin' (e-thesis from Durham university) reviews the history of all types of mill (corn, fulling, paper) on the Wear. c) Kirby makes extensive reference to the journals of the Surtees Society, especially XCV 'Memorials of St. Giles's, Durham', 1896, Introduction and p37, 110, 203, viewable at https://archive.org/stream/memorialsofstgil00stgirichpage/n9/mode/2u

9. The right to built a mill dam and mill pool is cited on p301 of Volume 2 of Hutchinson's 'History and Antiquities' as being granted by Gilbert, chamberlain to Bishop Pudsey. It is also quoted on page xxi of 'Publications of the Surtees Society for the Year 1895' Vol. XCV, 1896.

10. The full story is "9 January 1329. John of Ulgham was coming from Kepier fulling mill on 4 January when he entered the house of Richard del Marche in Durham and found there William of Hartlepool fuller with others sitting drinking there together. William asked him for the farm for his house which he owed him and John struck him with a long knife under his left breast and killed him." Translation from the Latin of Coroners' presentments of William of Walworth sheriff of Durham, Durham University Library Special Collections, Durham Cathedral Muniments: Locellus V:33. viewable on line.

11. John Tempest Esq. Bill in the Court of Chancery at Durham, 30th August 1726. Quoted on p110 of Surtees Society XCV 'Memorials of St. Giles's, Durham, Grassmen's Accounts', 1896.

12. Greenslade deeds at Durham University Library Special Collections. Co.Durham/Kepier/6 and 7 28 and 29 December 23 Charles II [1671]. Viewable on line.

13. The 1845 tithe map of St. Giles is on-line as DDR/EA/TTH/1/76 in Durham University Library special collections, Durham Diocesan Records. Other Victorian maps are on line at National Library of Scotland, www.maps.nls.uk. Durham XX and XXVII in the six-inch series (scale 1:10,560), surveyed 1857, published 1861. Also Durham XX.SW and XXVII.NW revised 1895, published 1898. Also see www.old-maps.co.uk. OS County series 1872-1895. 25 inch

series (scale 1:2,534), 1894. Available as paper reprint as sheet Durham 27.01 from Alan Godfrey Maps, Consett, DH8 7PW.

14. 'Water wheels as a power source' by Gerald Müller, now at Dept. of Engineering, Southampton University. Available on-line at hmf.enseeiht.fr/travaux/CD0708.

15. The Musgrave family history described in 'Ancestors and Aristocrats' at www.georgeclarkemusgrave.com/downloads/Ancestors_and_Aristocrats.pdf

9 Acknowledgements

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10 Appendix: Some 19th Century People at Kepier

The rights over property, like society itself, were hierarchical. The land owners for 250 years were the Musgrave family of Eden Hall, Penrith, who trace their ancestry, as de Mucegros, back to the Norman conquest [15]. In addition to Kepier they owned St Helens Auckland and Brusselton near Shildon. They used their Durham estates as investments, managed through a local agent. To the people at Kepier they were remote personages. They leased the land out in parcels to tenants-in-chief, who in turn might sub-lease, and these sub-lessees in turn might employ staff to do the work of farming, milling, quarrying, getting coal, etc. Even the working families had servants. Some heads of the Musgrave family were Sir Philip (6th Baronet, died 1795 aged 83), Sir John (died 1806), Sir Philip (died 1827), Sir George (10th Baronet, died 1872 aged 73). In 1913 Sir Richard George (died 1926) put Kepier estate up for auction in two lots.

The Musgraves employed a principal manager at Penrith, and a sub-agent in Durham. In the Musgrave archives we meet Mr. Christopher Dobson (writing in 1758) and Mr. L. S. (Lancelot Stordy) Dixon, principal manager to Sir George at least from 1845. In Durham the agent was William Taylor (around 1804), then Jervis Richardson of Darlington (around 1838), then his son William Richardson. The latter was criticised by Sir George in 1854 for not giving sufficient attention to the good repair of the mill, and seems to have been dismissed in favour of a solicitor, Thomas Storey of St Helens Auckland. Two other Musgrave solicitors were William Bleaymire at Penrith and J. and T. Griffith. In addition to drawing up leases, Griffith submitted some hefty bills for law work in opposing an Act of Parliament which would allow the Durham and Sunderland Railway Company to lay a railway line across his Kepier estate to the proposed new station at the foot of Gilesgate bank. In the

event he was unsuccessful and Durham goods station opened in 1844. In July 1842 Sir George was opposing another railway development – the Newcastle and Darlington Junction Railway Bill, which would affect this estate at St Helens Auckland. Agents and solicitors were generally shrewd business advisers who guided the likes of Sir George on gaining good income from his land through choosing tenants, fixing and collecting rents, dealing with bankers and organising timely property repairs.

Below is an extract from the land agent's six-monthly summary accounts submitted to Sir George Musgrave in 1835. They give a fair impression of what was going on at the time.

High Grange Colliery	The Earl of Durham	£500/yr
Colliery, Farm	Messrs Fenwick & Dixon	£134-10/$\frac{1}{2}$ yr
Farm, Brickyard	J. L. Jackson	£100-10/$\frac{1}{2}$ yr
Mill, Inn, Gardens	Thomas Gibson	£50/$\frac{1}{2}$ yr
Land, Stone Quarry	Thomas Renney	£32/$\frac{1}{2}$ yr

So here was farming, mining, brick making, quarrying, and running an inn, market garden and pleasure garden in addition to milling. Renney may have given his name to Renny's Lane in Gilesgate Moor.

The Musgraves' income seems gradually to have moved from agricultural rents to rents for coal mines. After 1800 new shafts were sunk and at least three mines established: Kepier Colliery on the Sunderland Road, Kepier High Grange near the railway line where the Belmont Premier Inn is now, and Kepier Grange Colliery north of Carrville. Older residents of Gilesgate Moor will remember the Duff Heap playing field next to Musgrave Gardens which was created by levelling the spoil heap from Kepier Colliery, while the mine buildings were taken over to become the City Council's works depot. In February 1811 a 17 year lease on Kepier Colliery was given to Thomas Fenwick of Dipton, a viewer (supervisor) of collieries. When the lease was renewed in 1828, Fenwick was joint lessee with Mary and John Dixon of Sadler Street, Durham. It was again renewed in 1839. By then John Dixon had died and his place was taken, alongside Fenwick and Mary Dixon, by Ralph Dixon and John Thwaites, an innkeeper. They leased 'all coal mines, collieries and seems of coal ... under Keepier and also with such parts of the adjoining lands and grounds late of and belonging to Ralph Carr Esq. deceased at or called Grange'. Though Sir George opposed the railway to Durham goods station, Kepier Colliery made good use of it by having a wagon way built down the hillside to join the railway line close to Kepier Hospital.

There were serious accidents at all these mines. In 1862 the crank-pin of the winding engine broke when there were 42 men and boys down the pit. They would have been trapped underground for over 24 hours until the engine was repaired had not John Thwaites had the foresight to have an additional drift tunnel 100 yards long dug into the mine, and it was though this that the men and boys made their escape. For the previous 21 years there had been no second tunnel. The case was much discussed across Britain as an example in mine safety. In 1864 a man and two boy workers died and a girl was severely scalded when the steam boiler exploded at Kepier Grange Pit. Two boys died in Kepier Pit in January 1868. And there were others.

John Thwaites was a major character. He lived to the ripe age of 91 and was married three times. His obituary in the Durham County Advertiser in August 1879 tells that he started work as a weaver at Salvin's factory in Church Street then became an innkeeper, first at the Queens Head Hotel in North Bailey, then The Shakespeare in Sadler Street, then the City Tavern and finally the Waterloo Hotel in Old Elvet. He ran a fast stage coach business between Durham, Newcastle

and Sunderland. Ever an entrepreneur, he next invested in coal mining, losing money at Sacriston colliery, but making a profit at Kepier, where he also leased Kepier Farm, the brickworks and quarry from Sir George Musgrave. He was said to have a quiet, unassuming disposition and had many friends.

Thomas F. Richardson took over Kepier Inn and gardens in either 1857 or 1860, probably as a sub-tenant of John Thwaites, and ran them until October 1868. Unlike Thomas Gibson, he did not also run the mill. He had a sports field nearby used for running races. A lot of his trade would have come from army volunteers and their families who crowded to the regular shooting competitions on the rifle range immediately north of the mill. The inn and gardens were not always peaceful. In 1864 Richardson himself was subjected to a 'murderous attack' by four thugs in his own gardens after he chided them for filching gooseberries. Richardson was succeeded as landlord by Thomas Anderson. In 1880 a drunk young man called Mark Sides kicked and punched two barmaids when they refused to give him another beer. Another event made national news: in 1881 two boys aged 12 and 10 were caught pocketing three pennyworth of apples in Anderson's garden, taken to court and given the 'scandalously severe' sentence of two months in prison with hard labour. The inn was used on many melancholy occasions to convene inquests on men, women and children found drowned in the river by the mill. By 1879 the inn was no longer profitable so Anderson wanted to quit, but no one was willing to take over the lease that year and it was advertised to let again in 1880 and then in 1883. In about 1890 the place closed down, was uninhabited for a couple of years then demolished on Sir Richard Musgrave's instructions.

The census returns also tell us something of the people living there. For example, the 1851 census says that the miller was Thomas Gibson, aged 46, and his wife was Matilda, aged 49. Their eldest son, William, 17, was assistant miller and they lived with daughter Margaret, 14, and younger sons Thomas, 10, and Robert, 8. Two servants lived with them; an elderly gardener called Richard Motherwell and a 17 year old house maid named Martha Blenkinsop. Ten years later the 1861 census lists the miller as John Hill, aged 27, born in St Oswald's parish Durham. His wife was Dorothy, also 27, and their three young children were John, aged 5, Sarah, 2, and baby Benjamin. They had a servant, 16-year-old Ruth Gowland. The Hills must have moved away in about 1863 when George Stonehouse took over. Nearby there was also the Kepier brickgarth where the Anderson and Wild families plus boarders and servants lived, working at the 'Harper's pond' clay pit and adjacent brick kiln. Their neighbours, the Peacock family, were agricultural labourers. Altogether there were at least 25 men and boys and 10 women and girls living at Kepier in 1861.

The last miller, George Stonehouse, was a rum character. He is almost certainly the same George Stonehouse, born in Bilsdale, North Yorkshire in 1809, which the 1851 census records as running Blackwell Mill on the River Skerne near Darlington. His wife was Sarah from Faceby, Yorkshire, one year younger. In 1854 Stonehouse was brought before magistrates at Darlington charged with adulterating his flour with alum powder and bean meal. His defence was that all millers had alum to make a cement to fill holes in the mill stones. In another miller's opinion, however, the 13 pounds weight found in the defendant's mill was sufficient for fifty years! The bench fined Stonehouse the highest penalty fixed by the law, namely £10.

Stonehouse must have been the under-miller at Blackwell because in 1858 a 10-year lease was taken by Thomas Taylor who was a corn merchant as well as miller. When Taylor went bankrupt in 1861, Stonehouse took over his lease. Within a few months, however, the mill failed. Parliament had enacted the Health of Towns Act which prompted the Local Board of Health to divert the River Skerne, blocking off the water which worked the mill. Stonehouse sought compensation and

a tribunal was held in July 1863. He told the panel that his profits were £400 a year, but had to admit that he had declared only £100 on his income tax return. The jury awarded him £2,500. He and his wife and son, George Henry, must have moved to Kepier soon afterwards.

At Kepier he was again in trouble with the law, this time for poaching salmon. In 1868 he and his son were charged with having illegally killed two salmon at the Kepier mill dam. They promised not to repeat the offence so were fined only 2s 6d each. However in September 1870, just a few days before the mill fire, father and son were again summoned before the magistrates for 'wholesale destruction of salmon' and they did not get off so lightly this time. The law allowed salmon to be caught only at specified times of the year using specified fishing equipment. However, the 19 year old George Henry had his own method: he stopped the mill, stood over the mill race and flung a heavy stone into the water when he saw a salmon. This stunned the fish – the lad jumped into the water and caught it. What he did not know was that P.C. Christison of the Wear Angling Association was hiding in the bushes on the opposite bank. The policeman waded across, challenged young George, who pulled only a trout from his pocket. The policeman was not to be duped and went into the mill where he found two barrels containing 29 salmon which had been taken only a day earlier. George and George were fined over £13. A week later the two of them allowed the mill to burn down!

In the 1871 census there is no George Stonehouse listed in Durham; the family must have moved away after the fire destroyed their home and their livelihood.