Chevin Tower - An Engine House Hidden in Plain Sight
A New Theory on a Local Landmark

Ian Castledine

Summary *The tall square building known as Chevin Tower sits on the hill directly above the Milford tunnel on the North Midland railway constructed from 1837-1840 by the railways appointed contractors to surveys carried out by George & Robert Stephenson. Until recently it has always been described as a 'signal tower', or a manmade landmark to aid railway surveying where direct line of sight was not possible. In2021 articles in the Midland Journal explored the use of the tower casting some doubt on the signalling interpretation and this led the author to examine afresh the structure, its location and context. This review has refuted the original theories concerning its construction and postulating with extensive supporting evidence that the tower housed a winding engine used to raise material extracted in the shafts and tunnel headings below to the surface, thereby speeding up the process of its construction. This pattern of engine house with a vertical cylinder driving a winding drum mounted above was one widely used in the north-east coalfield during the 19th century and its construction was likely to have been influenced by the Stephenson's whose background would have made them familiar with such an arrangement*

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Introduction

For many years there has been much debate about the purpose of the so called Signal Tower on Chevin Hill, Derbyshire near the village of Milford, and its connection to the North Midland Railway's 782 metre long Milford Tunnel below (1837-1840). The tower is at SK3453745102 and positioned exactly on the centre line of the tunnel.

The contract for building Milford tunnel was let by the North Midland Railway in about October 1837 and was completed by June 1840, in time for the opening of the line. The engineers for the route were George and Robert Stephenson, assisted by Frederick Swanwick. The winning contractor was David McIntosh who tendered £93,122 (equivalent to £8,524,000 in 2019).

A recent and excellent article in the *Midland Railway Society Journal,* No. 70, by Steve Huson explored the various accounts and descriptions of the tower and its use; these primarily being a 'Survey Tower' or a 'Signalling Tower'.

My interest in the tower's origins was raised by the lithograph shown in the article by Samuel Russell showing the construction of the North tunnel portal in which the tower is shown, we will return to the lithograph in due course.

Staying with the article, Mr Huson discusses the early use of semaphore towers and signalling such as those employed by the Royal Navy to relay messages from the Admiralty to sea ports, he expands on this considering if the North Midland Railway might have used the tower as an early form of railway signalling to control the passage of trains safely through the tunnel, having clear views of the line to both North and South of the tunnel.

Trains at this time were signalled using the time interval system whereby trains were dispatched with a given amount of time between them relying on the drivers' ability to spot a slower moving train ahead in order to avoid a collision; these were the early days of train operation and the railways were in a learning curve operationally. By use of a signalling tower an indication could be given to train drivers as to whether the tunnel was occupied by another train or not. Mr Huson makes a credible argument, however, that given the probability of fog and local industrial pollution in the valley (and low cloud as frequently seen by myself as rail photographer in the area) that the signalling theory is unsafe being reliant on visibility by both signallers and train crews to operate the system.

Mr Huson then explores the survey tower theory which seems to be more credible as, based on the local topography, neither end of the tunnel could have been seen from the natural hill summit indicating the need for a raised platform for setting out purposes. Mr Huson has redrawn the Network Rail (NWR) tunnel drawings and concludes that the ground above both tunnel portals could not be seen even from the top of the current tower but that the top of the shafts nearest the tower have a direct sight line coinciding at a point in the tower approximately 15 to 20 feet above the ground within the tower. Concluding that the safest theory is that Chevin Tower could be a survey tower based upon the new drawing.

From my interpretation of the drawings the top of the portals cannot be seen. Given that most surveying, as I understand it, is based upon trigonometry and line of sight I struggle to see how the setting out was achieved for the shafts position/depths, but again this is arguable as to whether direct sight lines are required to completely set out such an enterprise.

Comment has been made regarding the height of the tower as shown in the Lithograph to be discussed as too low. Would the whole height of the tower be seen from the artist's location, due to its topography? I believe not, based upon the drawing and mapping contours.

If the tower was indeed for surveying, after the initial surveys are completed any tower becomes redundant and would not require the huge structure as seen, as will be described later why build a tower with a huge structural load bearing centre column, with structural load bearing external walls onto a massive load bearing stone base?, this suggests something significantly heavier being installed beyond that of a theodolite. Typically survey towers were a tall slender column of timber or stone as below shown in Plates 2 and 3.

The Samuel Russell Lithograph

As previously observed my initial interest was raised by the lithograph presented in Mr Huson's article dating to 1840 and the latter stages of tunnel construction. I was immediately struck by the similarity of the scene to those of early 19th century illustrations of mining scenes, particularly the vertical winding engines of the north-east as illustrated in Plates 4 & 5.

My initial thought, after examining the lithograph, was that there might be an auxiliary shaft to the east of the tower being wound by an engine in the tower with a shaft-top structure for discharging waste or

Plate 2 The Stanage Observatory as seen c1960. (https://www.sheffieldhistory.co.uk/forums/

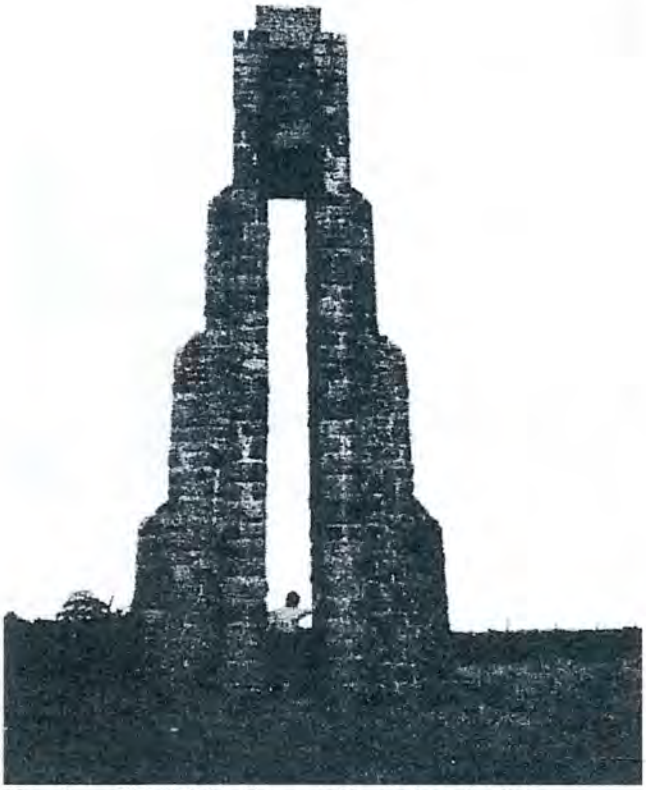


Plate 3 The sighting Tower, Kirby Malzeard, 1997. (https://www.sheffieldhistory.co.uk/forums/

perhaps even water (with the shaft being in Sandstone). However, that would put the chimney in the wrong aspect and given that the perspective used would actually mean the tunnel line missed the structure altogether looking at the direction of the rails, I went on to form the idea that some artistic license has been used. If you regard the tower as shown in a north - south aspect the chimney is then correctly orientated.

All this was sufficient to make me interested enough to visit the site in late July 2019. My objective was to apply my skills, as an engineer, and use my

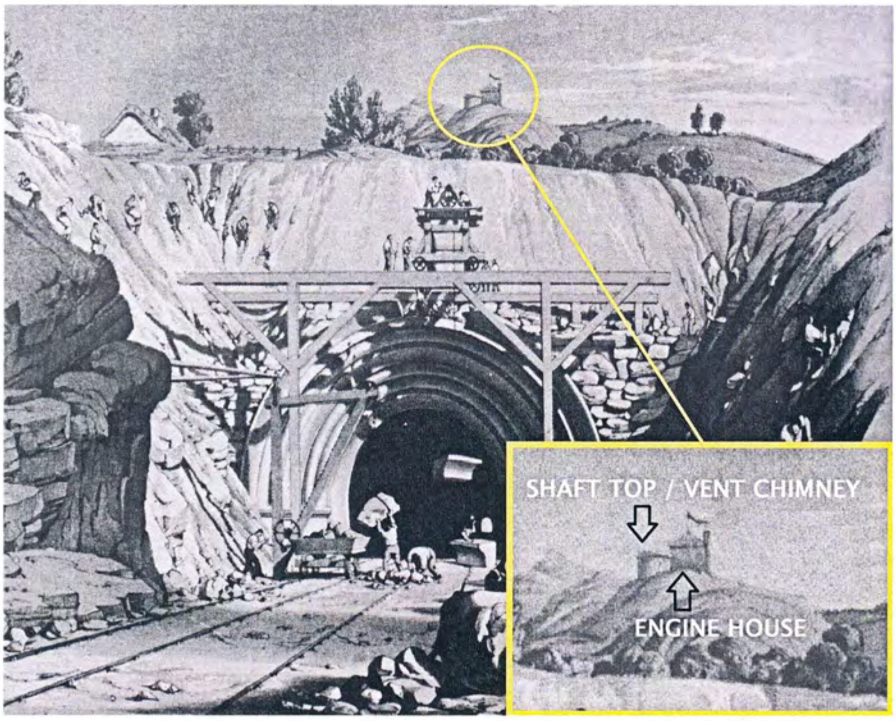


Plate 4 Lithograph of the northern end of the Milford Tunnel dated 1840. (Courtesy *Midland Railway Society Journal*, 70, p6)
upper inset - Monkwearmouth Colliery, Sunderland, George Watkins, SER 369b.
Lower inset - Burnhope Colliery, Fortune Pit, George Watkins SER 375c.
(*Stationary Steam Engines of Great Britain*, Vol 2, photos 87 & 62.)

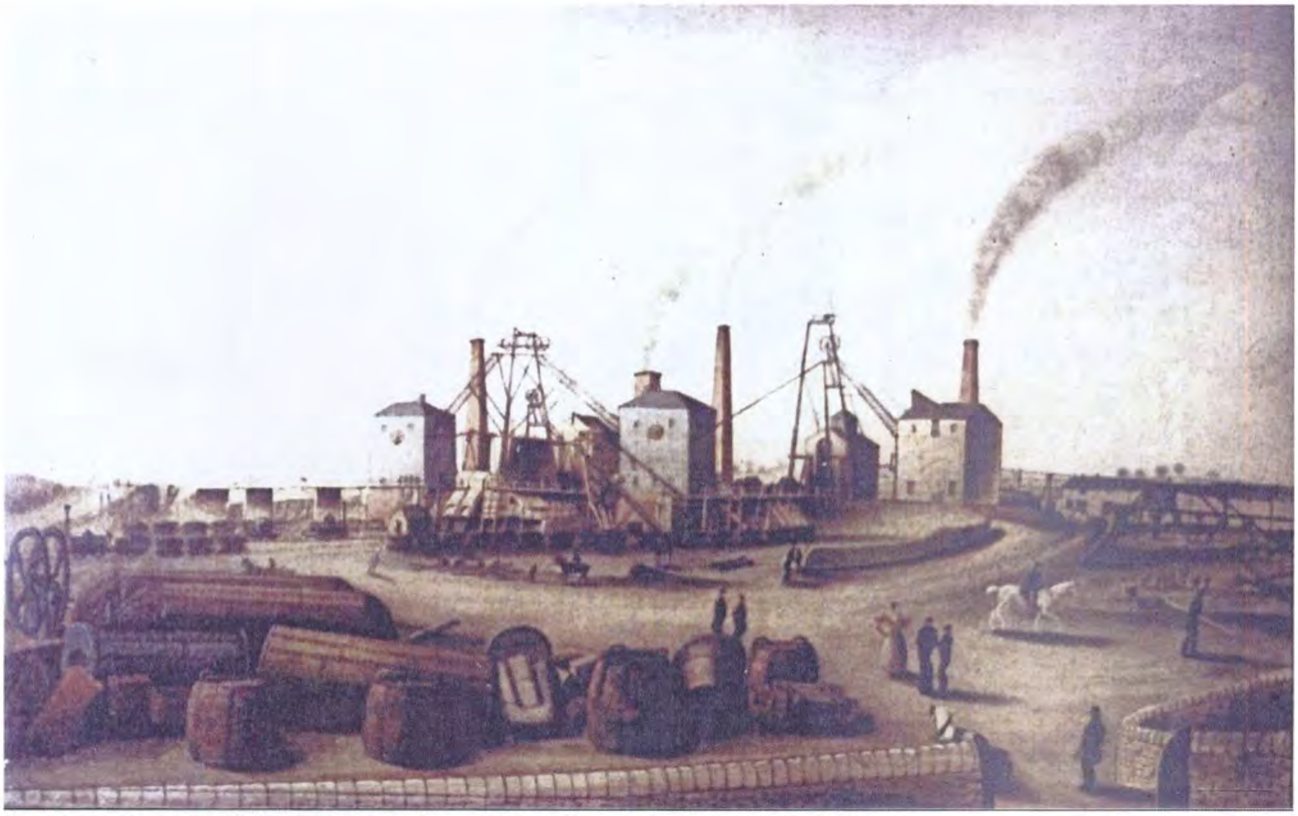


Plate 5 Crowtrees Colliery County Durham with it stall vertical winding engine houses.
(https://archaeologydataservice.ac.uk/archives/view/archaeoe1-76298)

experience of looking at many such sites. My primary questions being '*why is it built this way and what is its function*'?

On arrival I was immediately struck by the similarity of the tower to the tall colliery lever-type winding engine houses once a regular feature of the north-eastern coalfield and the massive nature of its construction. With permission of the owners I examined the structure and noted the following:

- The tower is exactly on the centre line of the tunnel and hence the centre line of the shafts according to the NWR plans, and are visible in the landscape with their associated earthworks (Figure 1). Vertical winding engines in the north-east that worked multiple shafts on collieries were also arranged this way. (see Appendix A for full tunnel cross section)
- There is an enclosure/wall attached to the east wall of the tower with two double rows of bricks in the floor running from front to back as often seen at engine houses and typically associated with boiler supports (Plate 6).
- On the east wall again there was the witness mark showing that a roofed structure of some kind existed over the walled area in the previous point, another typical feature of colliery architecture and adding weight to the boiler house theory (Plate 7).
- Also on the east wall there is a vertical line of heat affected stone work starting at about 6 feet high and continuing to roof height, typical of the marks left by a hot flue or steam pipe. It appears darker and wider at the bottom fading by the top (fumes would be cooling as they rose), there was also evidence of fixing for such a flue (Plate 8).

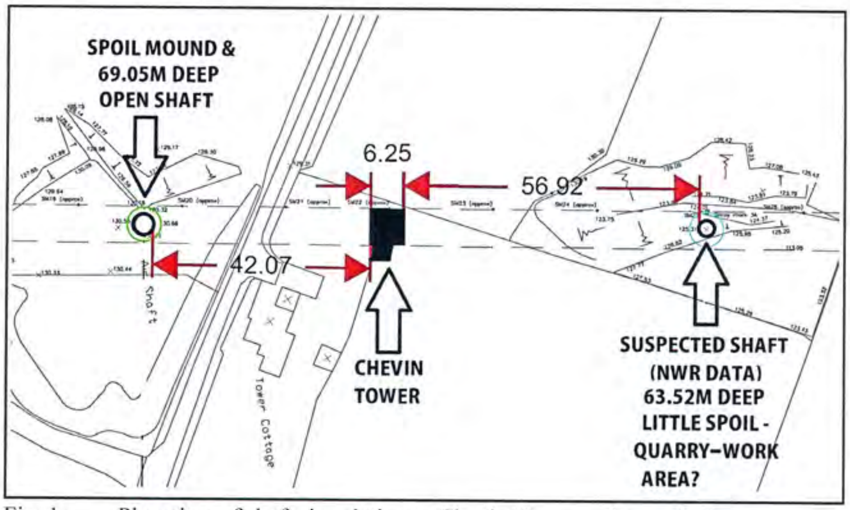


Fig. 1 Plan view of shafts in relation to Chevin Tower and tunnel alignment.

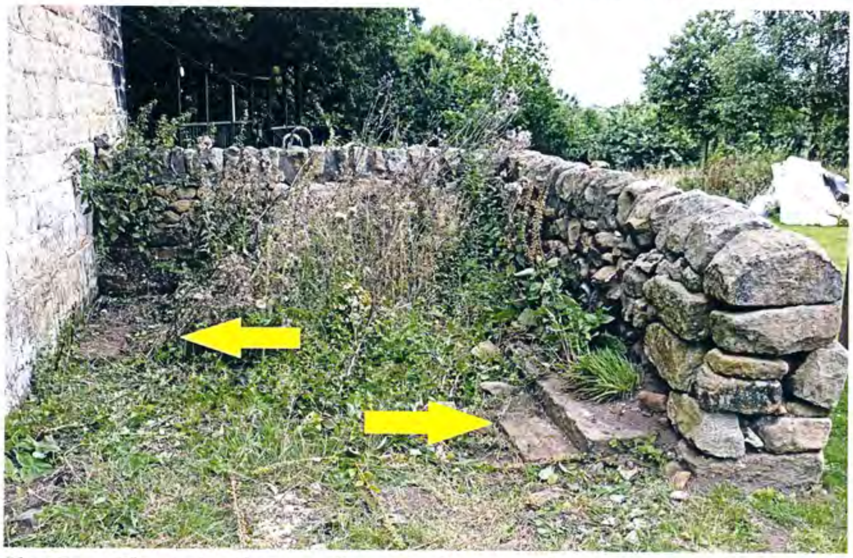


Plate 6 The enclosed space adjacent to the east wall. The arrows indicate the two lines of brickwork.

Plate 7 Witness mark on the east wall suggesting previous presence of a roof structure.

In addition, a large area of stonework at the base of the tower wall showed significant levels of heating consistent with a boiler being in close proximity to the wall.

Plate 8 (left)
Heat zones on the east wall.

Plate 9 (below)
A model of a Durham-type vertical winding engine made by Frank Woodall.
(Woodall F. *Steam Engines and Waterwheels,* p73)

Plate 10 Typical heavy stone base as per usual practice in construction of engine houses protruding beyond walls.

Having investigated many mine engine houses in the UK, the base of the tower is also very typical in that a raft of heavy dressed stone is provided as footings for the external walls.

At the time of my first visit, without access to the interior of the tower, my photographs taken through a gap under the door provided further evidence. The large slightly tapered column inside was very similar to the engine cylinder beds of vertical winding engine houses in the north-east.

The tower has also served as a domicile at times and, accordingly, shows some modification to floor levels and the possible addition of fireplaces.

High slotted windows at top of the north and south walls that would act as rope apertures, being directly in line with the shaft centre lines.

Initial conclusions and theories

The above points, based on extant archaeology, convinced me that I might be looking at a vertical winding engine house used in the construction of the tunnel shafts and to support the driving of the tunnel itself. This method of excavation was normal to increase the speed of construction. My visit convinced me that it was neither a signalling tower, nor a survey tower, despite all the reasons cited by commentators over the years; it would not surprise me that Stephenson who was familiar with the north-eastern coalfields, and who had surveyed the line, had applied his knowledge of steam power and mining techniques to such a venture via his appointed agents/ engineers. Not only being able to specify the engineering involved he might, possibly, have been able to provide suitable second-hand equipment for the short period of its operation to the contractor, or at least arrange for its manufacture. Given

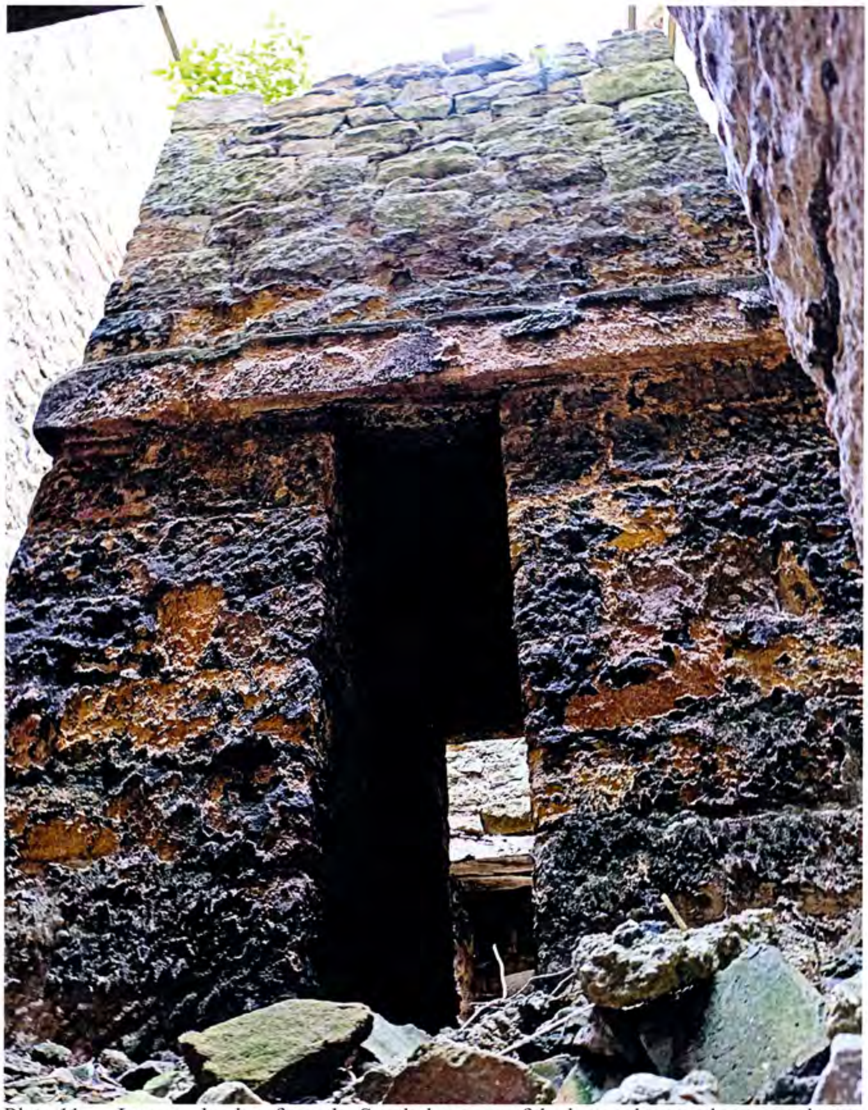


Plate 11 Low angle view from the South doorway of the internal tapered centre column.

Plate 12 The slotted windows in the north and south walls are suggestive of rope slots rather than for admission of light.

that the engine in this application would have had a short life of three years maximum use, possibly much less as Mr Huson cites that by 1st March 1838 all of the working shafts were complete and the headings well advanced, the economic case favours a second-hand source. Likewise, I am of the opinion that an older boiler might have been re-used, which seems confirmed in my drawings (see Figure 5).

Given the depths of the main shafts on top of the hill and using some rough estimates, I suggest use of horse gins for sinking, and rock removal, was impracticable. The deepest shaft (possibly two shafts) was over 200 ft. at a diameter of, say, approximately 10 ft. (a 78 sq. ft. area) before lining. This equates to something like 15,600 cubic ft. of sandstone and gritstone having to be raised. Using a sandstone density of 145 lbs per cubic ft. this equates to 2,262,000 lbs or 1,010 long tons; if we assume the second shaft does indeed exist, as shown on the NWR plan, this amounts to nearly 2,020 tons to be raised. However, there are some seven, possibly eight, shafts along the tunnel, the middle four being the deepest with the tower positioned roughly in the middle of these four.

Two of these four shafts are classed as hidden or suspected but, assuming they all exist, over 2,780 tons of stone just from the four shafts, plus any stone waste from the actual tunnel drives, would require removal. It could be considerably more than that, perhaps more than 4,000. Whilst the rate of shaft sinking is greatly dictated by the hardness of the stone, and the manpower applied, it would be significantly better to wind the four deeper shafts by an engine rather than by slower horse gins, effectively speeding up sinking and thus the ability to drive the headings from the various shafts towards each other in a quicker time. Was the engine required to meet the timescales set by the North Midland for tunnelling? It is quite possible that timescales were tight. This was a period of very rapid expansion of the railways.

If we divide just the estimated shaft tonnage of 2,780 into ½ ton at a time lifts we have 5,560 lifts - considerably more if you add in the heading spoil or other unknown factors. If, as Mr Huson says, the working shafts were complete by March 1838 and assuming work started in the month of November, i.e. immediately after placement of the contract (October 1837) then 5,560 lifts, over four months, would equate to around 46 lifts per day or about 324 lifts per week, in order to just sink the four shafts. Even if we assume that the two hidden shafts were not initially sunk that still amounts to 23 per day, or 162 per week. It is also worth bearing in mind that these lifts get progressively more time consuming as the shaft depths increased. Add in additional lifts for men and material movements this sounds very high based on the use of horse gins.

In coal mining it was not uncommon to wind multiple shafts from one engine; this was achieved by passing the winding rope/flat rope over dolly or pulley towers to the required shaft. This approach might adopted at Milford, given the straight line-of-sight. The owners of the tower made me aware of a heavily constructed 27" diameter wheel they found on site. Was this one of the intermediate rope supports? Being flat it was certainly made to carry a flat belt, or rope, of some kind.

This may explain why the tower if an engine house was built in stone, put simply the further away from the engine then the more the horizontal load on the rope/flat rope tries to pull the engine towards the shaft. The vertical lever-type winding engines used for the initial lighter applications on shallow pits had wooden upper engine house structures with the timber A frame of the engine acting as a free standing structure onto which the winding drum bearings were directly mounted, however as mines got deeper and the loads greater the engines and A frames were encapsulated in stone towers to handle the higher bearing loads and to support bigger engines.

In the case of Milford Tunnel with the four deepest shafts, near the tower, the engine in the Chevin Tower is at the worst case roughly hauling an average of c466

Plate 13 The 27 inch diameter wheel (left) found by the owner of the site. Its face (right) is flat and the purpose of the shallow groove is not obvious.

feet horizontally and 150 feet vertically at the shafts furthest away, to the north and to the south. At the shafts immediately to the north and south the engine is only hauling an average of c124 feet horizontally and c219 feet vertically, so it is perfectly feasible for working multiple shafts. With the engine being roughly central between these shafts this could also indicate the use of a counterbalancing system, e.g. as the engine winds up at the southern shaft it is also winding down at the northern shaft, thus enabling two shafts to be worked simultaneously and efficiently whilst minimising the load on the engine. It was common practice to carry out such balancing with this type of vertical design winding engine but not a necessity depending on the depth being wound, for a more shallow pit with little load on the engine balancing could therefore be avoided. However, with deep shafts (hence high engine loads) balancing by the working of two shafts or by the use of balance weights/chains over an additional headgear in place of a second shaft would help to reduce engine load significantly.

Detailed measuring visits

The tower owners allowed me to conduct two measuring visits in August 2019 which lead to the drawings presented later. We were also given access to the inside of the building.

The second session was conducted with Steve Grudgings and David Hardwick (an experienced building surveyor) and other respected commentators in the field of engine house design and conservation who supported my theory.

The primary findings of these two visits were:

- All previous mentioned points were confirmed.
- The arrangements of the internal walls were similar to the stepped construction of vertical winding engine houses in the north-east but also typical of engine houses where wall thickness reduces as loads carried reduce higher up inside the structure. The base walls are substantial and suitable for load bearing; a survey tower would not require external walls, especially load bearing ones. Likewise, why would a signal tower require a load bearing exterior wall of the large dimensions seen? Particularly in respect to the bending moment of a tall signal post, being worse at the top of the tower, hence a heavier structure being required higher up to counter the effects of wind on the top of the hill, which is not the case here. There is a suggestion that perhaps coloured lights were used in signalling but again this structure would be overkill for such a use.
- The tower is built as one complete structure, the variation in stonework higher up occurring as a consequence of the stepping of the interior walls and subsequent thinner sections.
- The floor levels defined by the floor joist holes are a later addition, probably made during conversion to domestic use suggesting different timber arrangements from original use.
- A number of larger filled/open holes were found on the northern and southern walls relating

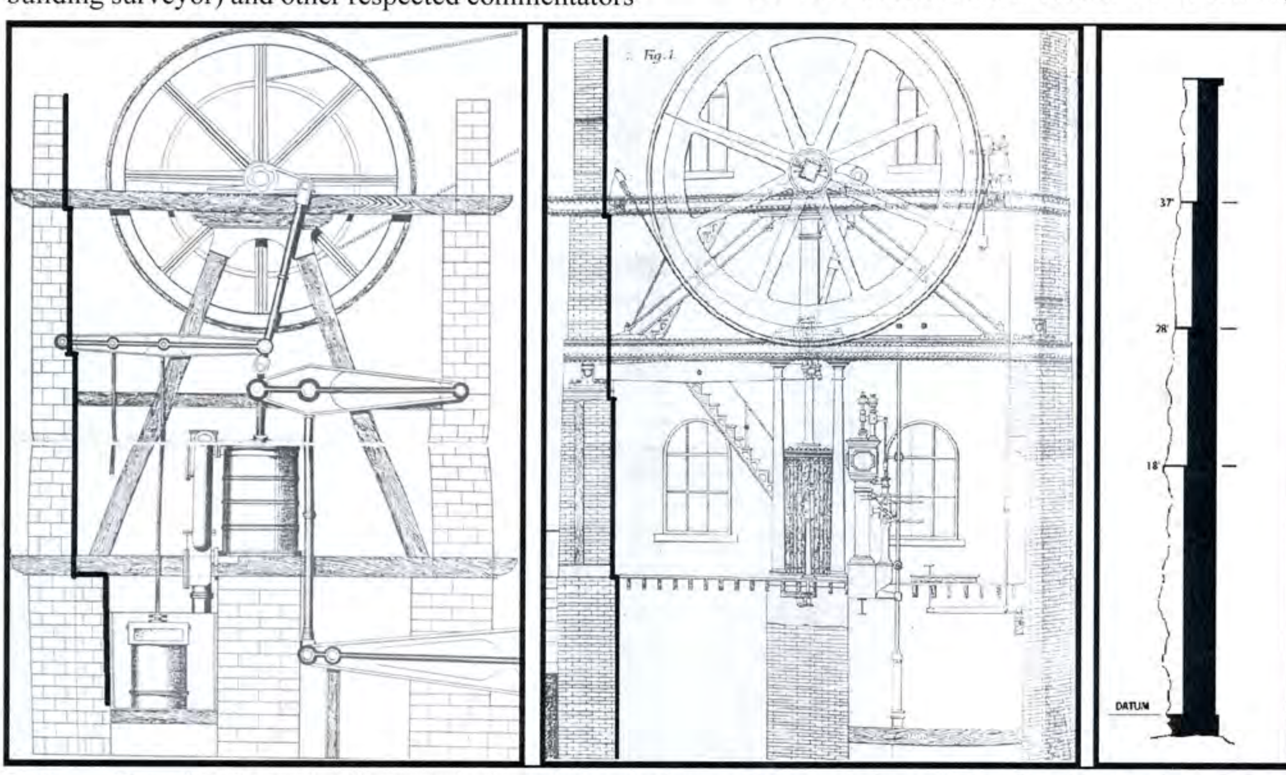


Fig 2 Examples of stepped wall construction in vertical engine houses. Rightmost is the stepped profile of the Chevin Tower wall. (Left - a typical Durham type winder (Hill A., *Vertical Lever Type Winding Engines*, pp10-11.
Middle a winding engine at the Wingate Grange Colliery (Engineering 17 October 1870, p447)

Plate 14 Holes inserted for later flooring arrangements.

Plate 15 Large c12 inch square beam holes filled, or left open, in the internal north wall.

to other use, all seemingly above the centre column, suitable for large beams running north to south, possibly corresponding to the A-frame beams used in the construction of Durham-type vertical winding engines (Fig. 2 left).

- A flat spot on the top of the internal tapered column indicates that a heavy item was mounted there, most likely the bedstone for an engine cylinder.
- Assuming this is an engine house, then any engine contained could not have been a condensing engine as insufficient space between the tower walls and the central column (engine bed) exists for a condenser.
- The existence of a flat area north of the Tower, in the base of a shallow quarry/cutting in line with the tower, suggested an area of industrial use or possibly even quarrying. (This was subsequently confirmed as a suspected shaft area from a NWR drawing).
- No trace of an engine pond was found. Was there a local water supply to feed the engine? Did they pump the shafts too to gain water for the engine? Water was certainly available for agriculture in the area.

Using the data and measurements collected, I made scale drawings of the engine house and examined the design and form of the vertical lever-type winding engine to assess if such a structure might fit into the tower.

The vertical lever-type winding engine

Vertical cylinder lever-type winding engines were developed and used widely in the north-eastern coalfields of England. The engineer, Phineas Crowther, filed a patent for the design on 28 Feb 1800. His design dispensed with the use of a heavy engine beam and parallel motion. Instead he used a 'Z' type twin lever mechanism in order to keep the travel of the piston rod truly vertical. Surviving examples can be seen at the National Railway Museum, York and the North of England Open Air Museum, Beamish.

The earliest written records for these engines are for those constructed during 1825/26 but it can be safely assumed that many were in operation by then, these engines may have started as simple non-condensing engines gradually being made more efficient by the addition of condensers. Typically these engines operated at a boiler pressures from 15 to 35 psi with the smaller, earlier engines, having cylinder sizes from 23 to 36 inch bore with a stroke commonly thought to be 5 ft. flat ropes from 3.5 in. to 8 in. wide were used on a winding drum of 7 ft., or larger, diameter.

Let's fit an engine

I applied a technique I have previously used whereby a typical engine arrangement is tested for 'fit' to an engine house by reducing/increasing the size of the engine drawing in proportion until it fits the space envelope.

Plate 16 The ex Chophill Colliery engine of 1855 under re-erection at Beamish c1974. (http://beamishtransportonline.co.uk/2015/01/remembering-frank-atkinson)

Whilst not an exact science, it does usually tell us that an engine arrangement is at least feasible. In this case I used an engine formerly used at Beamish No.2 Colliery as it was in proportion with the space to be filled. The engine is now at the North of England Open Air Museum and is a fine example of its type. Its re-erection has allowed us to see many of the features of its construction.

This first fit gave me the layout as produced in Figure 3. All dimensions were hand measured but are thought to be relatively accurate.

The engine, as fitted, does go nicely into the tower and to me, as an engineer, this is a case of '*if it looks right it probably is*'. The layout points to the following sizes as drawn:

Engine cylinder size 20 inch bore by 5 ft. stroke

This arrangement works fine giving the typical stroke of 5ft, the cylinder diameter being less relevant as a larger cylinder could be fitted and would fit in the above arrangement. If a vertical non-condensing engine was re-used in the tower, it is likely to have been a smaller early simpler engine from the early 1800s no longer suitable for use on the ever deepening mines, a cylinder of 20 inch bore may still be appropriate.

Flywheel diameter around 15 to 16 ft.

This fits precisely as per the Beamish engine so it is reasonable to expect this to be typical of that fitted to an engine as applied to the tower based on proportional drawing.

Winding drum diameter 7 ft.

Although on the small side 6 ft. to 7 ft. drums were not unknown. Again a larger drum could be fitted of a diameter more commonly seen as the space is certainly available; proportionally, this looks appropriate to the task if flat ropes are considered.

The snug fit of the engine to the tower explains the building's design better than the signalling or surveying purposes and would explain the archaeology of the tower's features. Whilst the exact size of the engine may never be known, the fit supports the case for an engine of a size and general design then in use in the north-east of England coalfields. The central support inside the tower terminates at approximately 16 ft. high and has a flat top suitable for an engine bed stone (shaded black on the drawing) located on it with the holding-down bolts trapped between the top of the support and the bottom of the bedstone. When the engine was dismantled the block may have been destroyed in removing the engine or alternatively during the tower's reconstruction to a dwelling to achieve optimum floor levels.

It should also be noted that the top of the winding drum lines up perfectly with the vertical slotted windows at the top of the northern and southern walls through which the winding ropes might have passed. These window apertures are approximately 4'6" tall by 2'6" wide. The winding rope used may have been of the flat type normally associated with this type of engine, but it is just as likely that good quality round, or flat, hemp ropes were used. It is unlikely that wire rope would have been applied as its application was then in its infancy.

Flat ropes came in many sizes, even if we assume a larger type of, say, 8 inches wide it would still be

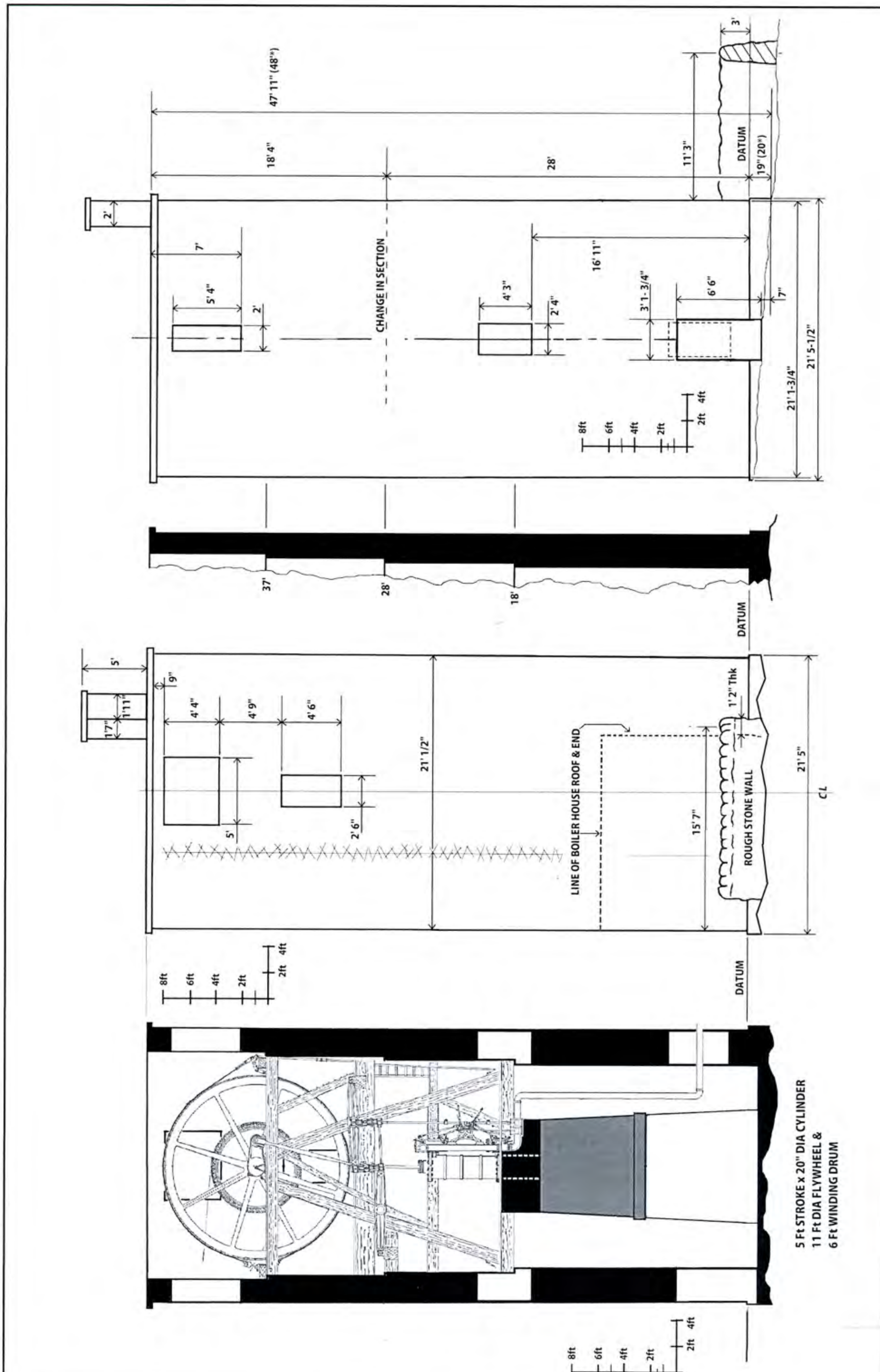


Fig. 3 Chevin Tower with Beamish No.2 engine overlaid to match the proportions of the tower space envelope.

possible to have two coils of flat ropes side by side on the winding drum in order to wind shafts to both the north and south. Likewise the winding drum could have had hemp round section winding ropes but normally the winder drum used would be wider and have deeper side guides to accommodate round ropes. The drum used in the tower would have been narrow possibly similar to that in Figure 4, if using flat ropes.

Plate 17 Flat rope, made of hemp or wire, was used for many years in winding applications. Although superceeded by round wire rope it's use persisted well into the 20th century, especially on older engines where re-fitting to accommodate round wire rope was not practical.

Steam supply

Every steam engine needs a boiler and based on the measuring carried out, and archaeological evidence seen, I suggest the arrangement shown in Figure 5 may be representative:

The boiler house seems to be a lean-to type shelter on the east wall of the tower, contained within a low stone walled enclosure open ended to the south. A clear joint line exists on the east wall of the tower

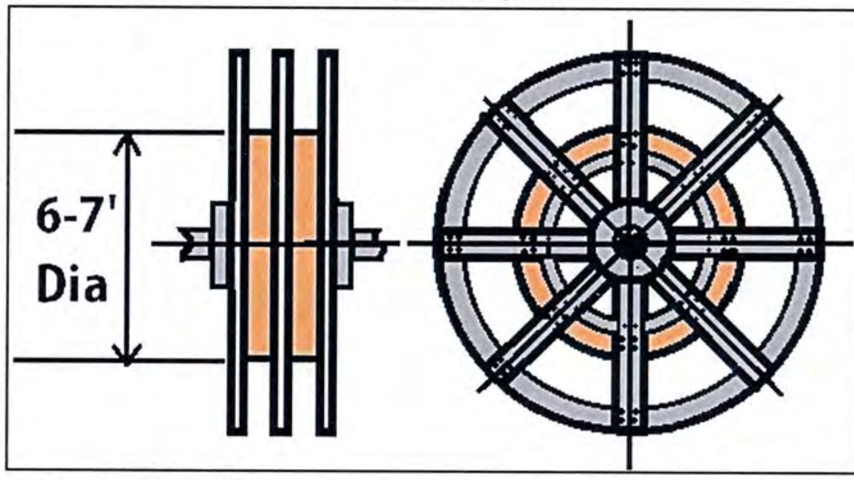


Fig. 4 Possible winding drum arrangement.

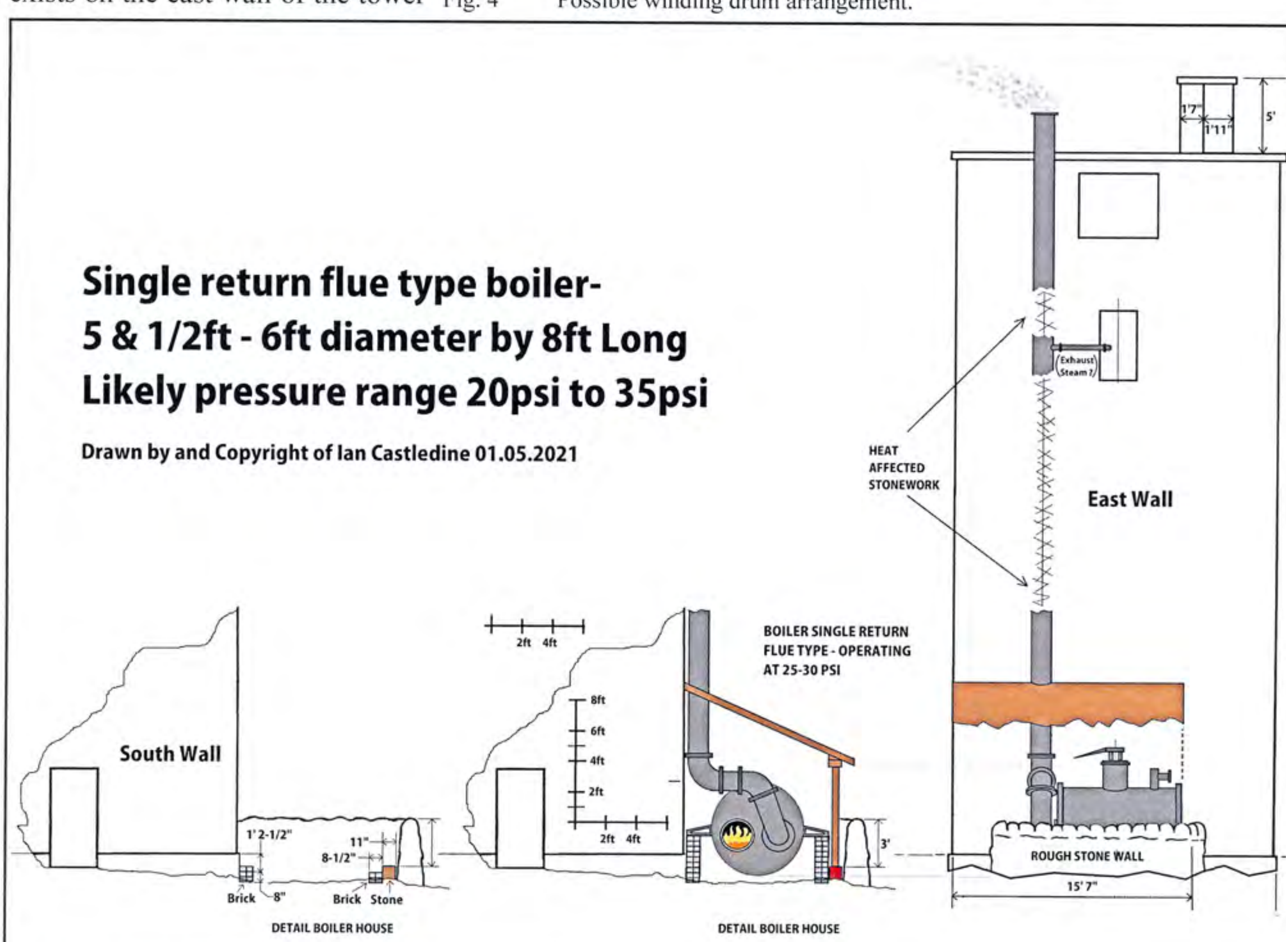


Fig. 5 Possible oiler house and boiler arrangement.

showing a roof structure was once present indicating the boiler was covered. The current owners confirmed a considerable amount of clinker has been encountered in the area of the tower. Archaeology in the floor of the boiler enclosure shows two lines of bricks running south-north indicating fairly typical boiler support walls (now mostly robbed away). There is also a line of stone at the side of the eastern most brick support which may have provided a base for the uprights supporting the roof.

My justification for the use a return flue high pressure boiler in the drawing is based on the following:

- The boiler enclosure is open to the south indicating this was the firing end.
- There is a vertical burn mark going up the east wall near the south corner suggesting that boiler fumes were exhausted at the firing end.

The height at which the burning to the wall commences gives a rough indication of boiler height, and the length of the enclosure indicates the boiler's length hence the dimensions used in the drawing.

Return flue boilers (pioneered by Trevithick) are known to have operated at pressures of 20 to 35psi and were manufactured in various sizes, some having engines even attached or built into the boiler, therefore the design suggested is suited to the application. By the period of the tower's construction better boilers were available, but given the temporary nature of the engine a small second hand boiler, such as the one shown in Figure 5, would have been compact and easy to manage. Based on the 162 to 324 lifts a week previously mentioned, the boiler would not have been over taxed or a bigger boiler required.

Coal was readily available in the area at Denby and at smaller mines in the Belper area, just to the north of the Chevin. These latter mines were ideal as they are adjacent to an old track way leading to the top of the Chevin Hill itself.

However, one missing aspect of operation is a supply of water for the boiler which may have been problematic given the height on the hill. I can find no mapping evidence of an adjacent engine pond or well. However, there seems to be a supply sufficient for troughs in the area and agriculture. Perhaps water was supplied/pumped locally to a water tank in proximity to the engine?

It was not uncommon for these lever-type engines to pump as well as wind by use of a drop rod from one of the 'Z' levers to an auxiliary beam arrangement. This begs the question was this applied to the Chevin Tower engine? It is interesting that a cutting/quarried area exists to the north of the tower terminating where NWR suggest another deep shaft exists and one possibility is it was used for pumping, not only to keep the tunnel workings, dry but also to supply the engine with water. Such arrangements are not uncommon, and a 2ft. stroke set of pumps might be viable in this case. This might explain the slot in the cylinder support column running south-north and the aperture on the base of the north wall allowing a pump rod to pass through to the shaft via the cutting to the north of the tower. Whilst this cannot be proved it can be considered as a serious possibility. Such an arrangement might have been similar to the method shown in Figure 6.

The fact that NWR suspect a shaft to the north of the tower, yet there is minimal evidence of spoil, raises the question if the shaft was sunk purely for practical purposes such as pumping and driving the headings but was not required for subsequent ventilation of

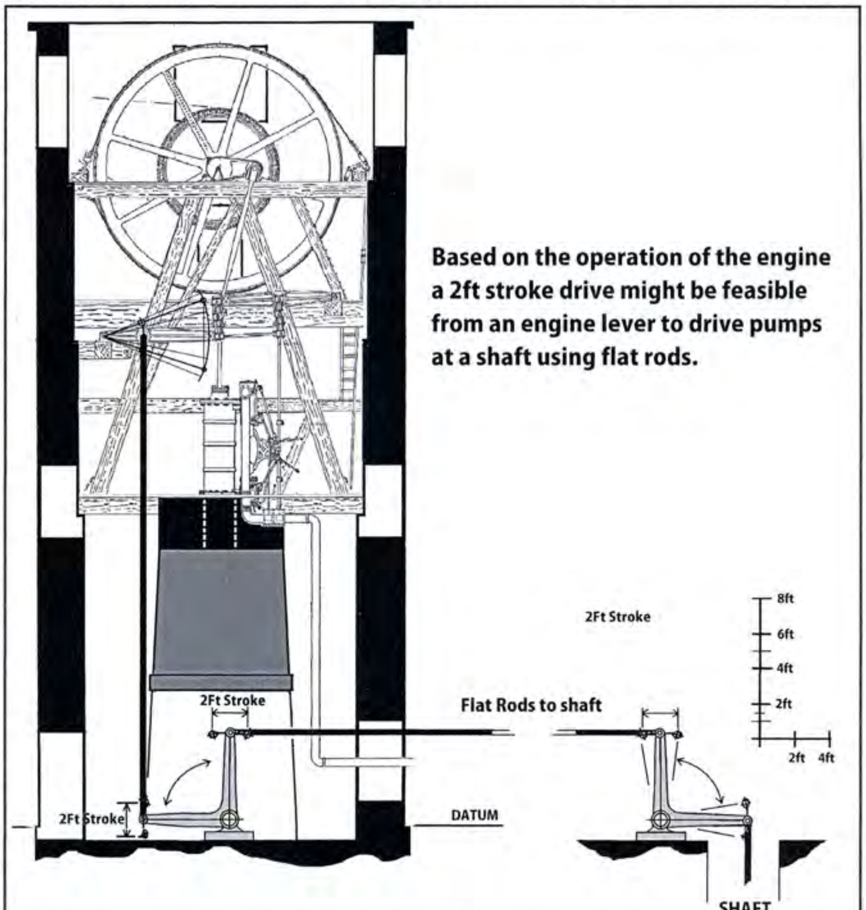


Fig. 6 Theoretical pumping arrangement based on the operation of the engine a 2 ft. stroke drive might be feasible from an engine lever to drive pumps located in a shaft by using flat rods and angle bobs.

the tunnel? This perhaps explains why there is little spoil as the shaft may have been back filled once its purpose was served, the shaft being left unlined and roughly hewn.

Surface arrangements

We have discussed the possibility of an engine and how it may have looked, but what was happening in the area of the shafts operationally? Returning to the lithograph there appears to be a structure to the side of the tower, connected to it by a line which may be a timber support or perhaps just indicating a winding rope, but it is obviously connected.

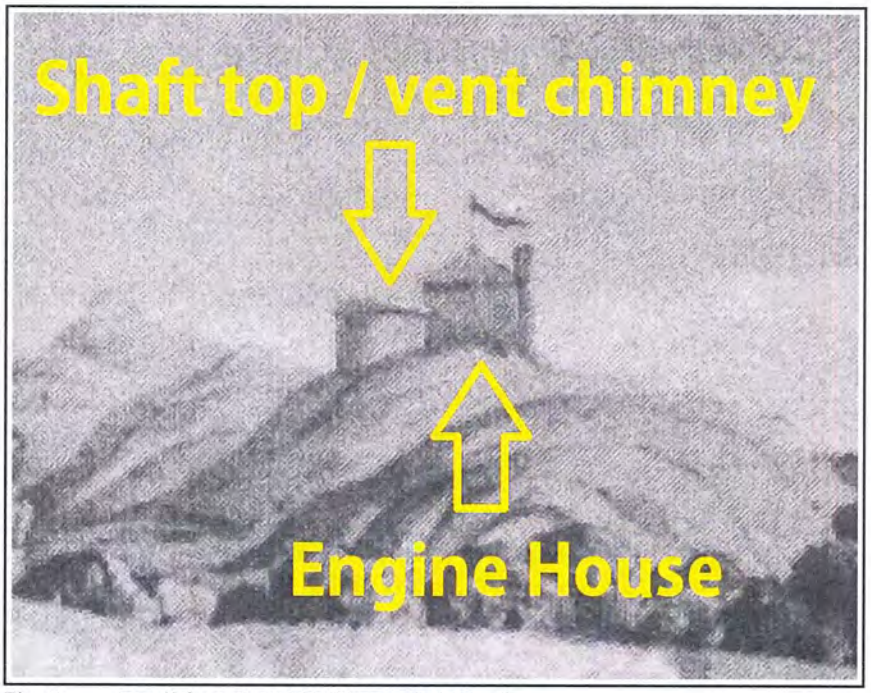


Fig. 7 Detail from the 1840 lithograph (Plate 4).

If an engine such as the one proposed is used to haul rock from a shaft, a substantial and solid form of head gear is required, and some method of discharging the stone from the kibble in which it is raised in the shaft is required.

That is what I believe the lithograph shows. Such structures were common enough in the coalfields for the discharge of coal at smaller mines and were usually just a timber structure (possibly even brick in this case) containing a very simple rotating chute, which could be angled over the shaft onto which the coal was tipped, so again this is fairly standard technology for the times. Larger coal mines in the main were using guided cages and tubs at this time but many smaller mines continued to use baskets or kibbles to raise the coal well into the 19th century, and the use of kibbles or buckets in shaft sinking continues to the modern day, in mining and tunnelling projects alike.

The structure at the top of the shaft as drawn appears shaded, right to left, which could indicate that it might be circular. But, however it's drawn, it appears as a solid and substantial structure nearly the same height as the tower. Circular shaft top structures (and square

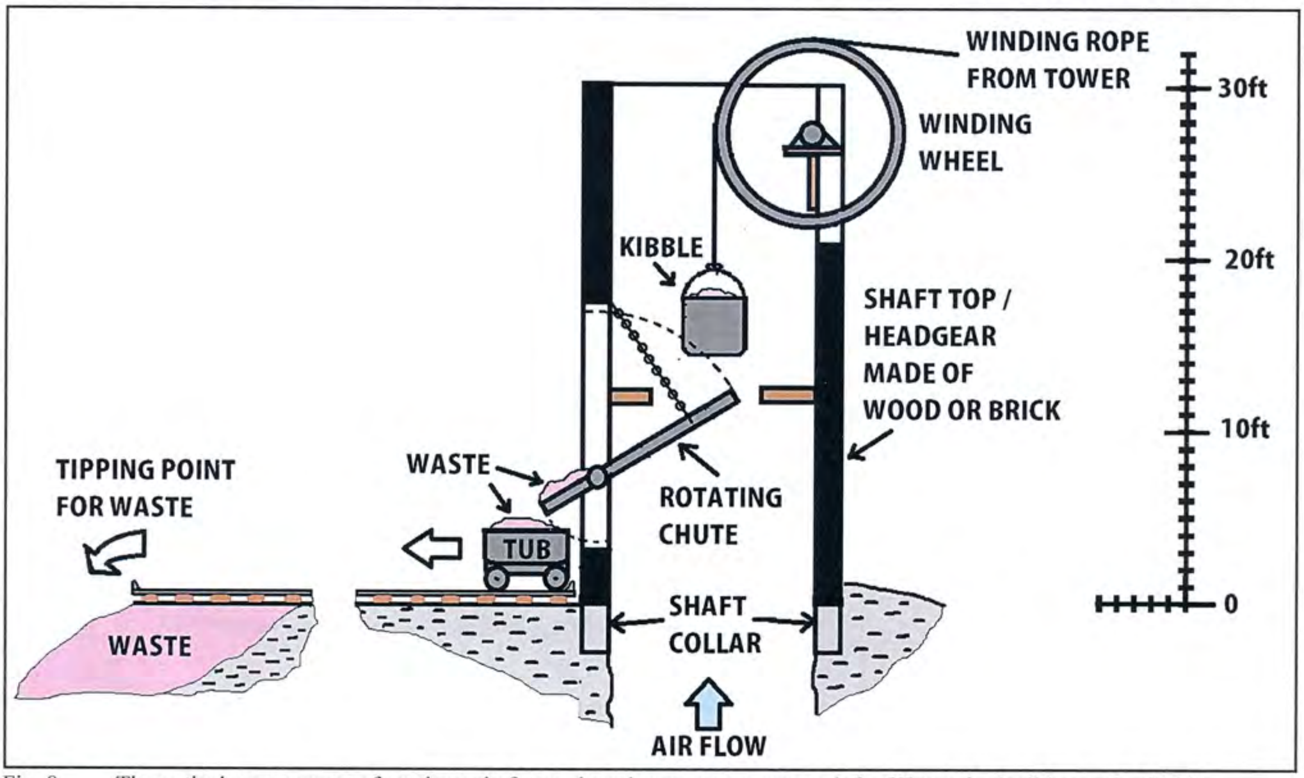


Fig. 8 Theoretical arrangement of southern shaft top - based on structure seen to left of Tower in the lithograph of 1840.

Plates 18 & 19 Brittain Pit, Swanwick dating from the 19th century now forms part of the Midland Railway Centre near Butterley. This would probably have been the upcast shaft.

ones) like this were often incorporated into headgears having a secondary function involving ventilation as well as serving the purpose of winding. There is a similar structure on a local colliery in the area near Ripley (Plates 18 & 19).

Ventilation of the workings would be critical assuming that once the shafts were sunk, the headings were blasted hence creating fumes which you would need to clear preferably as quickly as possible. This can be achieved by positioning a chimney like structure above the shaft and given the height in this case near the top of a hill it creates a natural 'venturi' effect drawing air, and fumes, up the shaft just like a chimney. If the probable shaft to the north of the tower was sunk at the same time as the shaft to the immediate south (thus

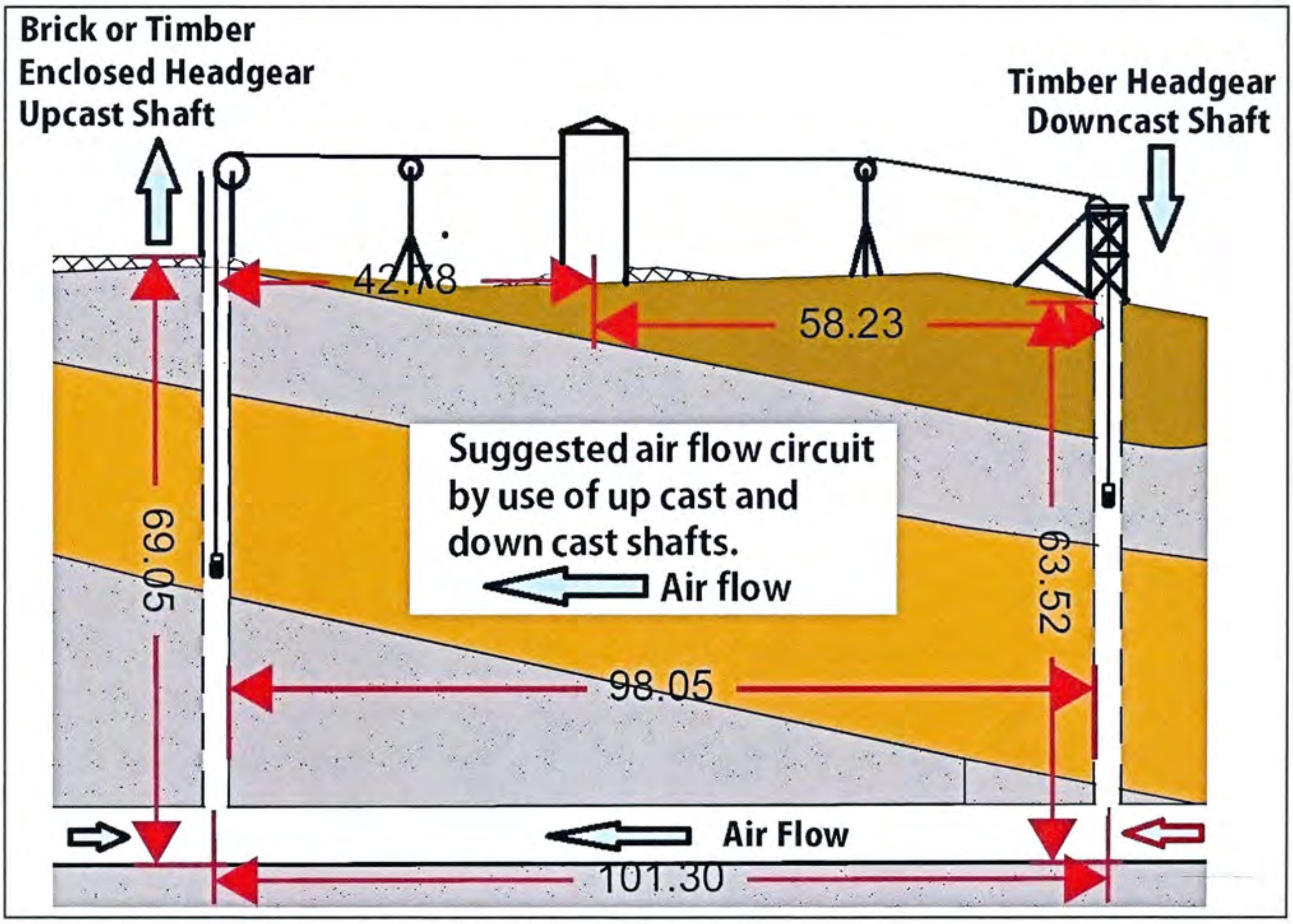


Fig. 9 Suggested ventilating arrangement in use during tunnel construction.

balancing the engine as previously discussed) and the two shafts connected underground by a simple heading, then we have the makings of a basic ventilation system typical of mines with upcast and a downcast shafts. The southern shaft is approximately 3.5 metres higher up the hill than the suspected northern shaft. If the southern shaft was then fitted with a combined headgear/ventilation arrangement of say 10 metres then approximately 13 metres (over 40 ft.) of 'Air' head could be gotten to gain the necessary ventilating 'Venturi' effect.

This would make further sense in respect of operations at the two shafts once sinking was complete, with the upcast (southern) shaft drawing waste from the headings and providing ventilation (drawing up fumes etc.) and the downcast (northern) shaft fitted with a more typical open frame wooden sinking headgear providing air, man riding (safe from fumes) as well as material haulage, including waste during shaft sinking, and may be even the pumping of water as discussed earlier. This all helps support the theory of the suspected northern shaft being a purely a rough auxiliary shaft later back filled with its own waste once the headings were all connected. Even if the suspected northern shaft does not exist the application of a combined headgear/air chimney at the southern shaft still makes sense, more so once the headings are joined from the other shafts, drawing fresh air in from the tunnel ends and fumes up and out at the shaft top. Hence, it is fair to assume that the shaft top structure was probably there as drawn in the lithograph.

The area around the supposed north shaft (probably back filled) remains a mystery. There are considerable earth works that lead me to conclude other activities other than sinking took place. The flat area to the south of the shaft is in the bottom of what could be best described as a small quarry, in the bottom of which is low sided cutting with evidence of walling. This leads me to ask 'did they quarry stone from there for use in the engine house, or perhaps even the tunnel'? Maybe this quarried area was a stockyard for materials to be lowered into the tunnel? In respect to the cutting in the base of the quarried area, was this simply a road from the quarry to the shaft, perhaps a channel through which the theorised pump rod(s) ran? What is clear is that significant activity, in relation to the excavations took place here. This is an area that warrants further investigation.

Conclusion

Whilst the surface operations around the shafts are open to interpretation, I believe that the extant archaeology of the tower itself confirms that this could be a lever-type vertical winding engine house, aligned on the centre line of the tunnel installed to facilitate the raising of waste/water from the shafts and subsequent driving of the tunnel headings. By the applications of scalable drawing, an engine as drawn would have fitted well to the extant archaeology.

Previous theories in respect to surveying and signalling do not appear to be supported by the

Plate 20 View south at supposed north shaft.

archaeology, I believe these theories were born out of a need by commentators over the years to describe some form of use for this prominent, heavily built structure and its juxtaposition to the tunnel. The technology of this type of winding engine being totally untypical to this area of the country means that over the years there has not surprisingly been anybody in a position to recognise the tower for what it may be, until now.

That said, Mr Huson's discovery that the top of the shafts nearest the tower have a direct sight line coinciding at a point in the tower approximately 15 to 20 feet above the ground (i.e. at about the top of the theoretical cylinder block within the tower) begs the question was the central column initially used to survey from during construction of the engine house or is it pure coincidence? Such a sight line might also be important as to the placing of any engine in relation to the shafts it was to work.

Comment has been made that surely such an engine would be remembered as a 'novelty', but would it? Steam power in the area, at both mill and colliery, was common especially along the Derwent Valley. Such power was an everyday thing in the era considered.

I have put considerable time into this theory and what is apparent is that more research and investigation is required and I hope to continue my search for references to the tunnel and, hopefully, the tower. I have looked for references with respect to sale of an engine and/or boiler but to no avail; unfortunately, no contractor drawings for the tunnel seem to be available.

It's amazing where a single lithograph can take you.

Sources

The following books were used in the preparation of this paper:

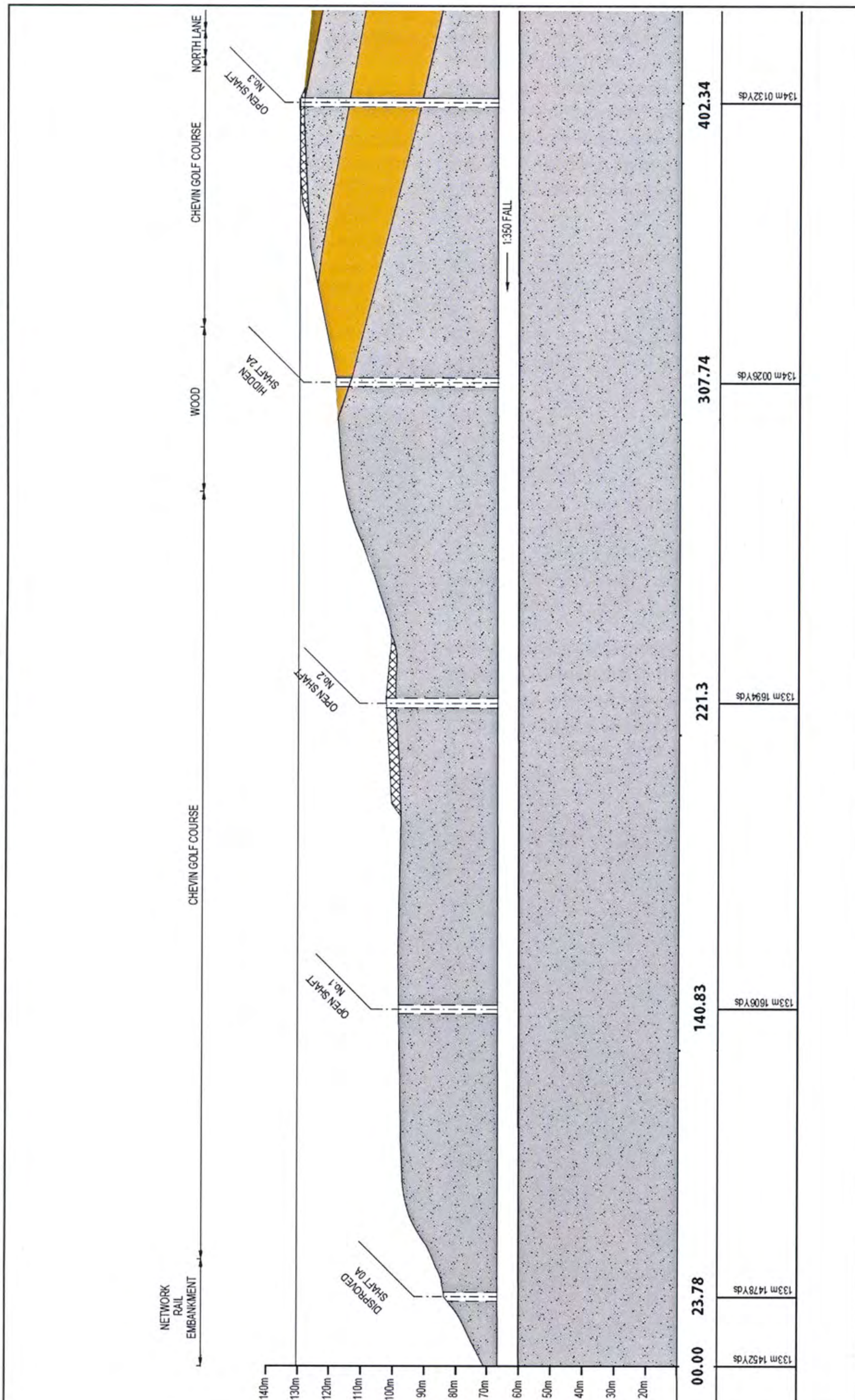
- Hill A., Single Cylinder Vertical Lever Type Winding Engines as Used in the North East of England, De ArchaeologischePers, Eindhoven, c1984.
- Storer, J.D., *A simple history of the Steam Engine,*
- Woodall, F.D., Steam engines and waterwheels a pictorial history of some early mining machines, Frazer Stewart, Waltham Abbey, 1991 (Reprint).
- The Midland railway Society, *Midland Railway Society Journal*, various editions.

Plate 21 The north wall of the tower.

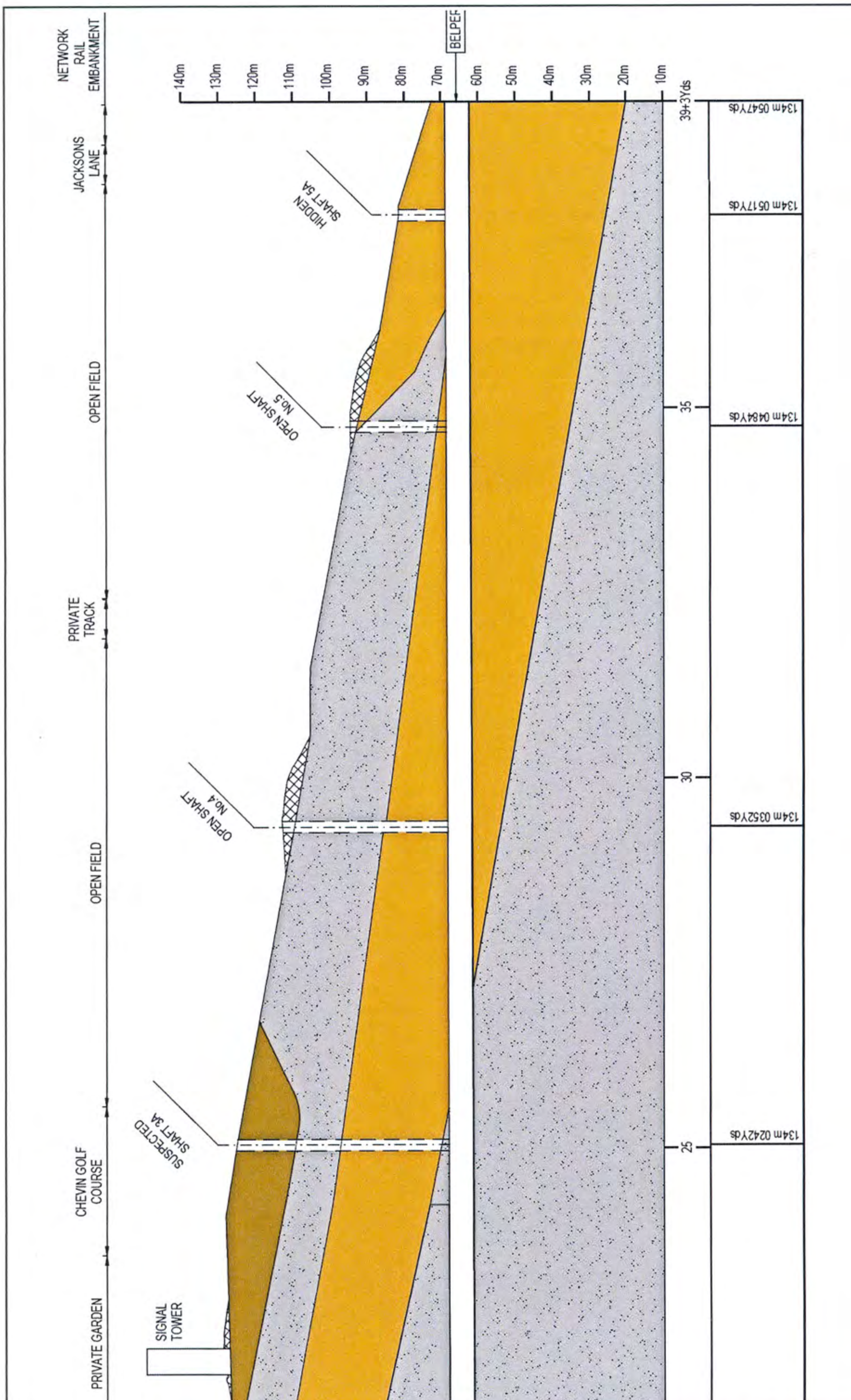
Plate 22 Not visible in plate 21 this apperature is at the base of the north wall.

Plate 23 This fireplace is possibly evidence of alterations from its period of domestic habitation.

Appendix A - Location and Section of Tunnel from NWR Drawing in two parts



Southern End



Northern End