THE GARTMORN LADE SYSTEM

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The historical sources quoted use a confusing mixture of Scots and Imperial weights, measures and volumes. There is a conversion table at the conclusion of the article to convert to metric equivalents. This is followed by a basic glossary.

Two lade systems were both built initially to carry a supply of water to drain collieries on two estates. Not only were these lades successful in achieving colliery drainage for a considerable period of time, both were subsequently utilised by local industries for both waterpower and as a source of water for industrial processes. Finally, both lades became public water supplies and, in the case of the Gartmorn Lade, the focal point for a Country Park.

The Craigrie lade, powering drainage engines for the Clackmannan Colliery was the earlier, being in existence by the beginning of the 18th century. The Gartmorn Lade was begun slightly later at the beginning of the 18th century, legal papers relating to the agreement of compensation water between the two systems being dated 1711.(1) Much of the Gartmorn lade can still be traced on the ground, a tribute to its long period of industrial history and present use as a country park.

At the time the Gartmorn lade was first developed, Scotland and England, although their crowns were united in the person of Queen Anne, still had separate parliaments, a reflection of their heritage of centuries of strife. One result of this strife was the depression of the Scottish economy, tied as it was to a feudal system where the principal occupation was agriculture. This agriculture was based mainly on the production of grain crops by the communal cultivation of areas of land laid out in run-rigg. A succession of grain crops was taken from a field until the soil was exhausted and the land was then left fallow and used for grazing until it recovered. This practice, together with the use of cumbersome inefficient oxen ploughs, primitive techniques of sowing and harvesting and the poor quality of cereal crops, kept the general population close to starvation point.(2) Such conditions led to low earnings for the farmers and low rentals for the estate owners, forcing both to seek other sources of income. This state of affairs continued in the Alloa area until nearly the end of the 18th century when the introduction of agricultural improvements and enclosures transformed agriculture.(3)

Towns and villages in the 17th century in this area were few in number, centred around the home of the local land owner, an ecclesiastical centre, or, in the case of the Burghs, a market or port. The two market towns of Alloa and Clackmannan developed around Alloa Tower and Clackmannan Tower, the ancestral homes of the Erskine and the Bruce families. Surrounding these two

main settlements the bulk of the population lived in a scatter of fairm toons, many of whose locations are shown on a map drawn up by John Adair about 1681.[4]

The Alloa and Clackmannan estates stretched back from the shores of the River Forth on to a ridge of higher ground to the north and were drained by the River Black Devon and the Brothie Burn. The Black Devon, rising near Saline 13 km to the east, had a large catchment area and a considerable flow of water, apart from during the driest parts of summer.[5] The Brothie Burn, on the other hand, originated in a swampy hollow about 3 km to the north west of Alloa and had a much smaller flow, which also fluctuated severely as the seasons rotated. The marshy pool from which the Brothie Burn flowed was named Gartmorn Loch. The first part of the name Gartmorn is likely to be Scandinavian in origin ('Garth' – an enclosure) and the 'morn' possibly represents ('morren' or 'more' – a moor or marsh).[6] There are a large number of 'Garth' place names in the south west corner of Clackmannanshire. It is possible that these place names represent the western spread of Scandinavian influence related to the appearance of waves of Danish invaders into the east coastal areas of Scotland in the 9th, 10th and 11th centuries.[7]

Both the Black Devon and the Brothie Burn entered the Forth in a series of winding, semi-tidal loops which afforded sheltered harbours or pows at Clackmannan and Alloa for early small, shallow-draught ships. The waters of the Black Devon had long been used as a source of power. John of Mentieth, Sherrif of Clackmannan reported in his accounts the quarterly rent of *The Mill of Clackmannan for the term of Whitsunday 1357* for two pounds Scots.[8] In June 1368 Robert Erskine was granted *mills and multures* in the lands of Alloa and Forestmill.[9]

The first coal workings in the Alloa and Clackmannan area are difficult to date but the records of the Scottish Parliament mention coal workings in East Scotland as far back as the 12th and 13th centuries. In 1291, for example, Dunfermline Abbey was given the right to work coal on the lands of Pittencrief.[10] Coal was used locally at first, but exports are soon recorded, indicating that landowners were selling it outside the area, transporting it by sea.[11]

Coal working in these early times faced a number of challenges. Firstly, there was the need for labour for what was hard, dirty and dangerous work. From the late medieval period, the early miners were bound to the colliery and sold as part of the colliery property.[12] T.J. Salmon noted that *…as late as 1771 the value of the ownership of forty good colliers, with their wives and children, was estimated to be worth £4,000…..*[13] This state of affairs persisted until the late 18th century when the 1775 Act gave newly engaged miners the chance of freedom, but it was not until the end of the century that the system was completely ended.[14]

The next challenge was to keep workings free of water. Earliest coal

workings were located near the coast or in the sides of a valley where seams had been exposed. Coal was dug out until the workings could no longer be drained or the roof was in danger of collapsing, when the workings would be abandoned and new ones opened further along the seam. Where seams lay close to the surface, small shafts could be dug and workings 'belled out' at the base. Again, when drainage or roof collapse problems occurred, these bell pits would be abandoned.[15]

Drainage was to be one of the most serious and costly challenges to pit owners, becoming more difficult and expensive as shallower seams were worked out. By the 14th and 15th centuries, more extensive workings became accessible by the use of day-levels, very gently sloping tunnels or adits driven up from a stream in the base of a valley to intersect with a coal seam. The area of coal above this point could then be drained through the day-level into the stream. Once the initial cost of driving the tunnel, or day-level, had been met, maintenance costs were low.[16]

As mining gradually exhausted the areas which were easiest to work, shafts had to be sunk to reach deeper parts of the seams. At this point drainage became a serious issue. By the 16th century the Records of the Scottish Parliament report several licence applications for *engines* for mine drainage, with suggestions that *power was supplied by men, horses or water mills*.[17] By the end of the 16th century, larger mines were appearing. Between 1590 and 1625, Sir George Bruce of Carnock developed an extensive coal mining and salt-making industry near Culross. The colliery had two shafts, one on land close to the shore and one sunk below the high water mark, surrounded by a raised mound to protect against flooding (moat pit).[18] Horse gins (engines) were by then in common use to deal with mine drainage, driving endless chains with wooden buckets. In Alloa in 1791 it was reported that *horse machinery (cog and run – a wheel with teeth running into a trunion or lanthorn pinion, as in the old corn mills) with chains and buckets had been used to drain to a depth not exceeding 15 fathoms*.[19]

A further challenge facing coal owners was the need to get coal to the surface. Shafts, usually not more than 10 to 12 fathoms deep, provided a means of getting the coal up. This early limit to the depth of shafts was related to the use of *bearers*, usually women, who carried a single piece of *great coal* up the shaft from the pit bottom to the coal hill.[20] In Alloa it was noted in 1791 that *The depth of a bearing pit cannot well exceed 18 fathoms or 108 feet. There are traps or stairs down to these pits, with a hand rail to assist the women and children, who carry up the coals on their backs*.[21] The weight and amount of coal carried by these women bearers was considerable. It was stated that *a diligent bearer often brings up from the bottom of the pit, 6 chalders or 9 tons per week. The weight a good bearer can carry is very great. A lame bearer brought a* piece *of coal 2cwts out of a pit 12 fathoms deep. Another woman carried a piece of coal 400 yards estimated at 3 cwt*.[22] In 1815 Robert Bald, a mining engineer who campaigned for the emancipation of women and children, described the work of colliers and the bearers still

employed in carrying coals in the Alloa Colliery working in conditions unchanged since the beginning of the 18th century. He stated in 1815 *..the colliers leave home at 11.00 pm and start hewing coal into large pieces (great or sea coal) weighing about 2 cwts. Colliers work five days a week and 10 – 12 hours a day.*[23] He witnessed a woman *..take on a load of at least 170 lbs avoirdupois, travel with this up the slope of the coal below ground, ascend a pit by stairs 117 feet and travel 20 yards more to where the coals are laid down. All this she will perform no less than twenty four times as a day's work.* and notes that she is *paid 8d a day for her labour*.[24] Coal haulage in the 18th and early 19th centuries could also be achieved by winding a rope around the shaft of a horse gin. A bucket was attached to each end of the rope. As a bucket with coal came up an empty bucket went down.[25]

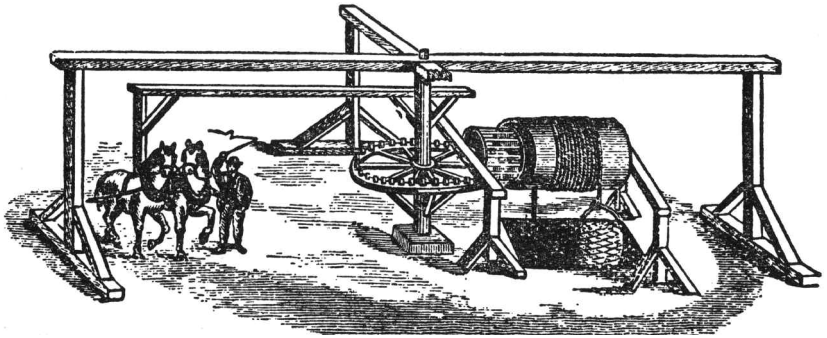

Figure 1. Horse Powered Winding Engine (From A Glossary of Scotch Mining Terms, Barrowman, J, 1886)

Much of the coal from early pits around the Forth estuary was mined in single lumps of one to two cwts to be loaded on to ships and exported by sea as 'great coal'.[26] There were regular conflicts between coal owners and local people as the price for exporting often exceeded that available from local sales. Exports were forbidden in 1644, unless local demand had been met first and the Estate of the Scottish Parliament introduced new customs duties *On coal exported in Scottish or English bottoms of the value of £20: 6 shillings. On all coal of the same value exported in foreign bottoms: 12 shillings.*[27]

Land transport of coal to the shore was often accomplished by tenant farmers as part of their lease.[28] When coals were carried in small carts by tenants, the quantity was uncertain and often not considerable.[29] They provided a small, horse drawn cart carrying loads of some six cwt.[30] As the roads were unpaved and of very poor condition[31] stocks of coal were built up on a "coal hill" close to the top of the shaft and transported to the shore when conditions were suitable.[32]

In the Alloa and Clackmannan area there were four main seams of easily workable coal: a splint coal named the *Upper Five Foot* Coal, the *Nine Foot Coal*

(four feet of splint coal, three feet of cherry coal and a band of ironstone on top), the *Alloa Cherry Coal* or the Under Five Feet Coal and the *Alloa Splint Coal* or the Three and a Half Foot Coal.[33] These seams are generally inclined to the NE at a gradient of about 1 in 6 and separated into a number of different coalfields by a series of east to west and north to south running faults.[34]

In 1689 Sir John Erskine, 6th Earl of Mar, inherited the Alloa estate which already had a well established colliery,[35] mostly drained by a day-level which ran in a northward direction from near Carsebridge.[36] The estate was "*heavily encumbered with debt*"[37] but fortunately, the 6th Earl held a number of important offices of State; Secretary of State for Scotland 1705-1709 and member of the British Privy Council 1707-1714)[38] and married the wealthy Lady Frances Pierrepont, daughter of the Duke of Kingston-upon-Hull.[39] These sources of income enabled him to improve his estate and continue to develop his colliery. He was also able to secure a separate custom house for the port of Alloa in 1710. Previously, the port of Alloa had been managed from Bo'ness. The new Alloa customs area covered the harbours at Kincardine, Kennetpans, Clackmannan, Alloa, Cambus, Manor, Stirling, Fallin, and Airth (Elphinstone). The status of a customs port led to a considerable increase in the amount of shipping using Alloa and encouraged exports of coal.[40]

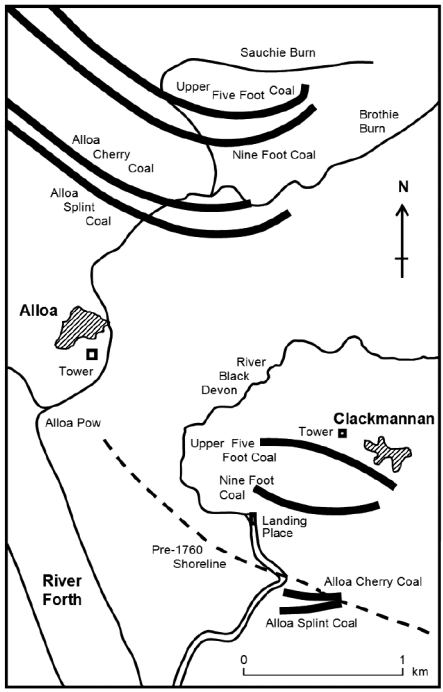

Figure 2. The Alloa and Clackmannan Coalfields.

In 1841 it was reported that there were *still traces of the early day-level running northwards from Carsebridge under Post Hill*.[41] This day level would have drained a significant section of the Upper Five Foot Coal and a small section of the Nine Foot Coal.

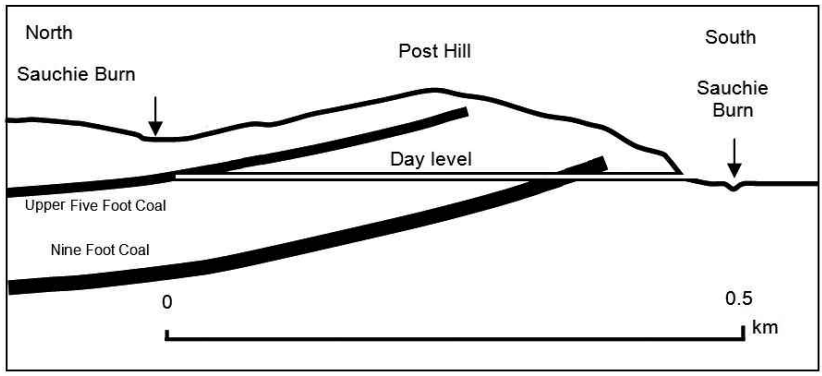

Figure 3. The Carsebridge Day Level.

However, the coal drained by the day-level was being worked out by the end of the 17th century and Sir John Erskine was searching for a means to drain a more significant area of coal from a new shaft further to the north of the day level. Not being able to find sufficient expertise in Scotland, he sent his colliery manager to Newcastle in 1709 to examine the methods used there to drain the mines and to return with drawings of the machinery required.[42] His manager reported water wheels and horse gins driving chain pumps, the depths of pits commonly being 20-30 fathoms. Horse gins were expensive and only worked in shallow pits.

Chain pumps were also expensive. The chains for a pit of 80 yards deep cost £160 and, if a bolt gave way, the whole set fell to the bottom and broke every wooden bucket. They were also inefficient as, *although each bucket was full of water as it was lifted from the pit bottom, none of them were more than half full at the discharging point near the axle tree, owing to the leakage of the joints and the vibration of the chains.* [43]

In 1710 Mr. George Sorocauld, an engineer from Derby, was sent for. He visited Alloa for several days and, for a fee of £50, advised the construction of a series of pumps driven by a water-wheel.[44] As the nearby Sauchie Burn did not have a sufficient flow, the 6th Earl, who owned the land at "Forrest", decided to build a 16 feet high weir across the River Black Devon to raise the water into a lade to carry it to his *new sinke at Hultone*.[45]

George Sorocauld surveyed the line of a lade from Forestmill to Gartmorn loch where the first earthen Gartmorn dam was thrown across the Brothie Burn

below the marshy loch of Gartmorn to store winter water for use during the summer drought. Levels for the lade were taken using *..a large wooden quadrant, set upon a tripod with brass lights, along the upper radius, the index being a plummet suspended by a fine thread. This instrument was of no use in a strong wind, but when the wind was moderate, the oscillation of the plummet was brought to rest by immersing it in water. For this purpose an attendant was required to carry a wooden cup with water, and apply it to the plummet, at every observation.*[46] Gartmorn Dam was the largest artificial body of water in Scotland at this time. Another lade, some 3 km long, took water to a new pit at Holton.[47] Although George Sorocauld had suggested the use of pumps to lift the water out of the shaft, the Earl of Mar was unable to find skilled wrights and had to settle for a bucket-and-chain gin.[48] A description of the gin and wheel at Holton is given in the New Statistical Account of Alloa.[49] *… a water wheel, with its axle cross the pit mouth; over this* (axle) *were several tiers of endless pudding link chains of iron, and when the water was scarce* (in the lade) *then comparatively few buckets were attached to the chains.*

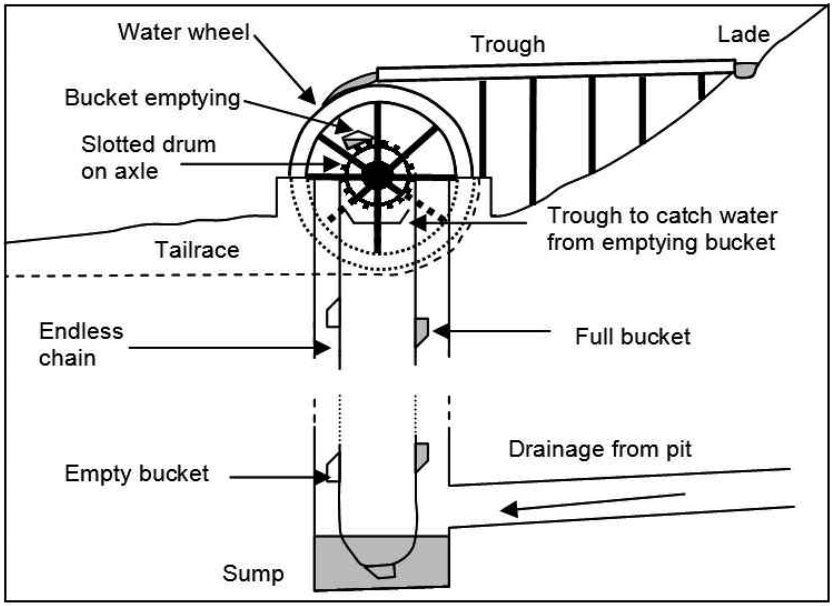

Figure 4. Bucket and Chain Gin.

The shaft at Holton went down 48 fathoms to intersect the seam known as the Nine Foot Coal. It drained the large area of this seam which underlies Keilarsbrae, Post Hill and Holton.[50] General Roy's map (Plate 1) shows a *Water Engine* in this locality lying on the same general contour as a continuation of the lade from Keilarsbrae.[51] As shown in Figure 5, the quantity of coal made available by this drainage was several times greater, both in area and in thickness than that drained by the Carsebridge day-level.

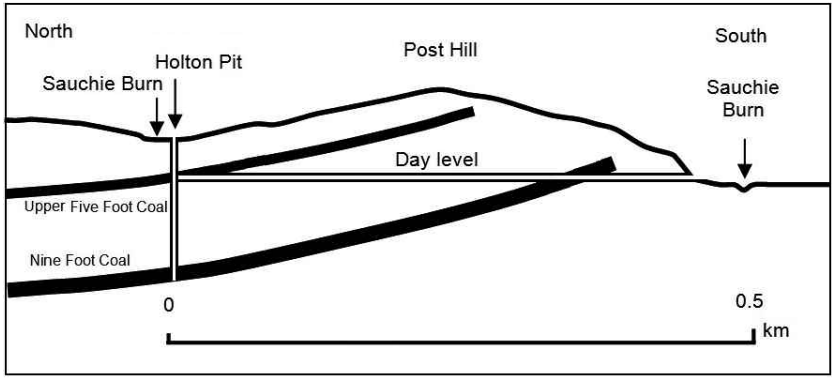

Figure 5. Holton Pit Drainage Shaft and the Carsebridge Day Level.

After passing over the water wheel at the pit and being joined by the drainage from the mine, the water ran into the Sauchie Burn, joined the Brothie Burn then flowed past the town of Alloa, through the newly laid out pleasure gardens of Alloa House towards Alloa Pow. Here it was collected behind an earthen dam, passed through a sluice into a steep stone trough, through which it was released at low tide to clear the harbour of mud.[52]

It was unfortunate that, in the first few years of working this new pit, Sir John Erskine, the 6th Earl of Mar became embroiled in the Jacobite Rebellion. This involvement ended in his subsequent exile to the court of the Pretender in France. Eventually, the Earl fell out of favour there and spent his remaining years wandering Europe. He continued to have a strong interest in developments in Scotland and Alloa town, suggesting many improvements there.[53] His estates were forfeited by the Crown and were managed by the Commissioners for Forfeited Estates from 1716-1724.[54] During this time there were no substantial improvements to the colliery, in fact the output of coal fell dramatically. In 1724 the Estate was purchased by Lord Grange, the 6th Earl's brother, and relatives. Lady Francis Erskine, the 6th Earl's daughter married her cousin, the son of Lord Grange and most of the estate and was eventually restored to the Erskine Family in 1739.[55] Lord Thomas Erskine immediately embarked on a continuation of the mining developments initiated by the 6th Earl. He began by constructing a water powered winding engine to hoist coal.[56] This machine was an adaptation of the bucket-and-chain gin, the water wheel shaft connected to a winding drum. The water wheel was 18 feet in diameter and had an axle 39 inches in diameter.[57] So that the drum could be worked in both directions the water wheel was constructed with two sets of buckets facing in opposite directions. Valves in a trough above the wheel directed the flow of water into either set of buckets or closed off altogether. A length of rope was wound several times round the axle and the ends adjusted so that when one end was at the base of the shaft the other was at the surface.

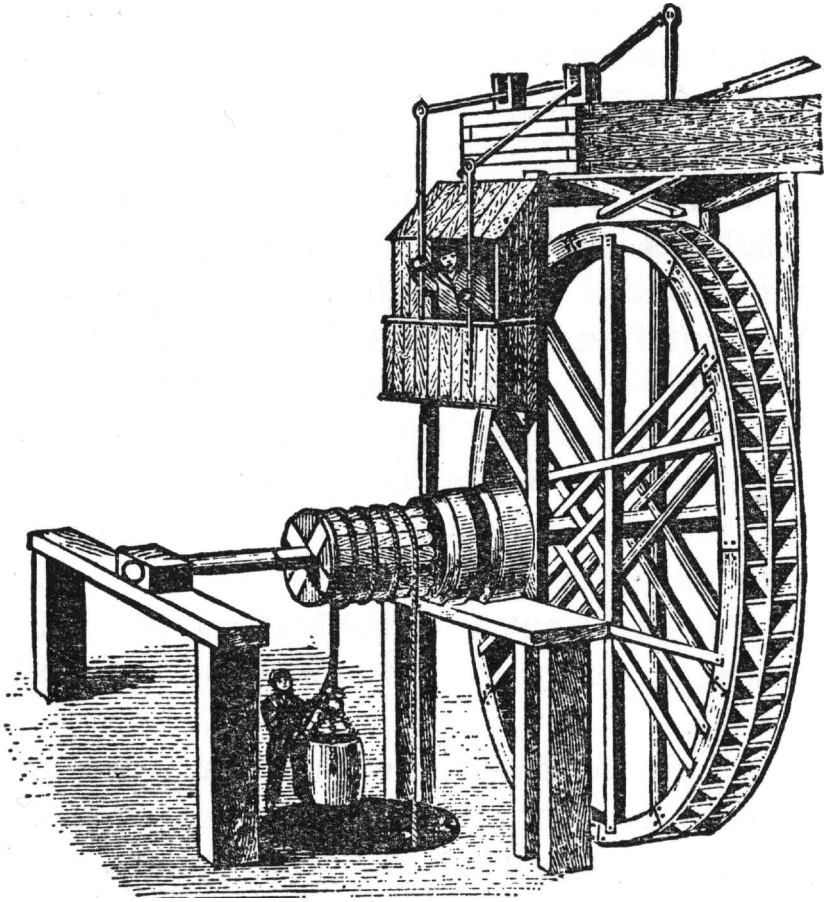

Figure 6. Water Powered Winding Engine (From A Glossary of Scotch Mining Terms, Barrowman, J., 1886)

A wooden bucket was then attached to each end of the rope. When the bucket at the bottom of the shaft was filled with some 6 cwt of coal, the appropriate valve was opened and the wheel turned to wind up the full bucket while the empty bucket, acting as a counter balance, travelled down. This winding engine was so efficient and so cheap to run that the managers of several English collieries paid visits to the Alloa colliery to study its construction and mode of operation with a view to introducing it into their own workings.[58] Despite the low cost of this machine and the eventual introduction of steam power, women bearers continued to be employed in the Alloa Colliery until the Act of 1843 prohibited the employment of women and children underground.[59]

Figure 7. Water Powered Pumping Engine at the Old Watermill Pit
(Photograph belonging to the late James and Isabella Snaddon, by kind permission of their granddaughter, Mrs Sadie Archibald.)

The hydraulic pumps which Sorocauld had suggested in 1710 were finally installed in the Old Watermill Pit about 1760 in a shaft 50 fathoms deep to the Nine Foot Coal.[60] The Old Statistical Account of Alloa states that in 1796 *….the lade is conveyed into pipes for forcing the water to an engine for raising water out of the coal pits and another for drawing up the coals*. indicating that feed pipes and siphons were used.[61] A supply of water for the Old Watermill Pit came from the lade just before it entered into the Keilarsbrae woollen mill. It ran into a cast

iron pipe, acting as a siphon, which carried it down under the Sauchie Burn and up to a trough which fed the water to a 30 feet overshot water wheel with three feet wide buckets and three feet cranks. These connected to two balanced wooden beams linked to pump rods in the pit shaft. As each beam lowered the pump rods in the shaft, a series of 10 inch diameter cast iron lift pumps, at about 30 feet intervals, lifted the water from the colliery sump to the surface where it was added to the lade.[62]

A similar system of pumps was in operation at the Collyland colliery where the pipes were *...made from plane-trees, having a hole bored up their centres, fitted with iron hoops and having spigot and faucet joints*.[63] Each column was worked by one of the pump rods, the 'pump stroke' being the down stroke of the pump rod so that the weight of the rod was used to lift the water out of the workings. Although each pump rod weighed several tons, the beams were arranged so that the two pump rods were counterbalanced.

The original earthen Gartmorn dam was replaced by a 320 yards long stone-faced dam in 1785 at a cost of several thousand pounds Scots. This was rebuilt in 1827 by the Alloa Colliery manager (John Craich) for £300 when it threatened to give way.[64] The tremendous storage capacity of the Gartmorn reservoir and the drop from the shoulder of Post Hill to the Pow gave the Gartmorn lade considerable potential as a source of water power. Also, the water coming from Gartmorn dam was added to by the water pumped out of the colliery workings, all of which made the tailrace of the Gartmorn lade a much sought after supply of water.

Soon after the dam was constructed a mill was built for grinding snuff and shredding tobacco adjacent to the lade next to Jellyholme Farm.[65] The Second Statistical Account (1841) notes that *tobacco and snuff were manufactured here to a great extent—what was called the Alloa pig-tail having been well known in London. The trade in these is still considerable*.[66] Jellyholme mill was later converted to grind wood for dyestuff. In 1827 it had been converted to paper making by John and Andrew Young, paper makers of Alloa. In 1852 it was converted to a woollen mill.[67]

In 1791 the First Statistical Account of Alloa[68] reports that there was a carding and spinning mill and a lint mill at Keilarsbrae. A corn mill had been built on the lade opposite the town in 1731. This mill was rebuilt about 1780 by George Meikle and the new building contained two 19 feet water wheels. The water below these mills originally powered a snuff mill and a fulling mill. Lastly, the water flushed any accumulated silt out of the harbour at the Pow and into the channel of the River Forth.

By the mid-19th century three more woollen mills, Gaberston, Springfield and Kilncraigs, were using the water of the lade to turn water wheels to power their machinery.[69] In addition, the lade supplied water and power to the distillery at Caresbridge.[70] The Gartmorn lade, at one time or another

throughout its life as a supplier of water power, drove three pit engines and eleven water wheels as well as cleansing the Pow.

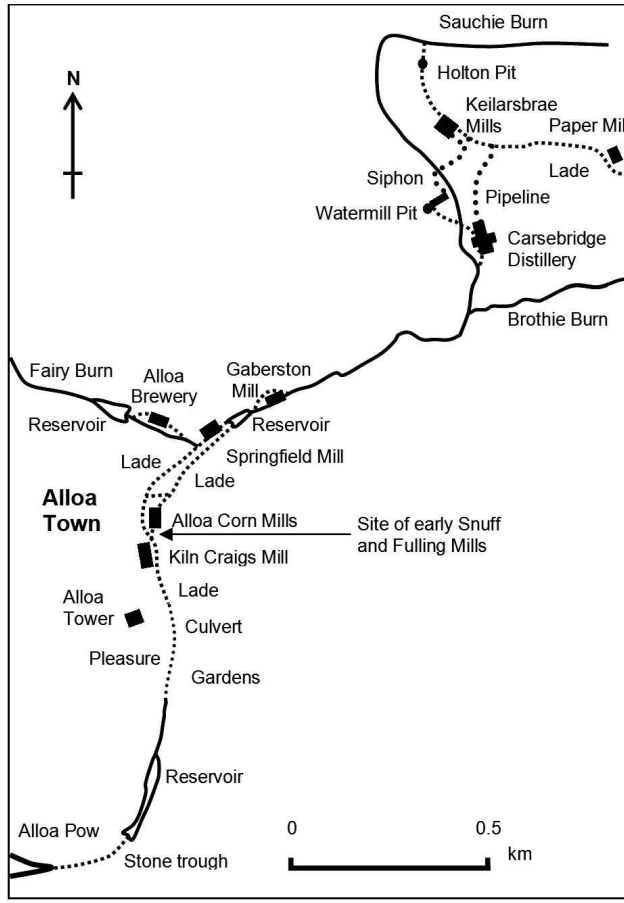

Figure 8. The Development of the Gartmorn Lade for Industry

Newcomen was granted a patent for a steam engine in 1706 and these were in use in Newcastle collieries between 1712 and 1720.[71] Although the first Newcomen steam engine was erected in Scotland at the Elphinstone colliery in 1720[72] the first steam engine in Clackmannanshire was not built until 1764, at the Collyland colliery.[73] The water powered winding engine at Holton continued to operate into the 19th century.[74] When in 1840, the responsibility for the Gartmorn reservoir had passed into the hands of the Alloa Coal Company, they were still using the Gartmorn lade as a source of water power for their the Old Watermill Pit pumping engine.[75]

The early endeavours of the Bruce family of Clackmannan together with the foresight and entrepreneurial spirit of John, the 6th Earl of Mar, kick-started development in the Clackmannan and Alloa collieries. This was further promoted by the continued attention of Lord Thomas Erskine, Lady Francis Erskine and John Francis Erskine who carried these initial developments forward.[7]

The water power potential of the Gartmorn lade, together with the introduction in 1768 of a network of waggon ways providing land transport between the collieries and the Pow of Alloa,[77] made available to the town of Alloa a cheap and reliable source of both water power and coal. This led to extensive industrial growth. As the lade also powered the drainage and winding engines which enabled this coal to be worked in its early stages, it made a significant contribution to this industrial growth. This early advantage created the circumstances upon which the commercial and entrepreneurial skills of local business people combined to develop the town of Alloa as one of the major industrial centres in Scotland of the 18th and 19th centuries.

The rapid growth of the town of Alloa in the early 19th century saw the demand for domestic water supply begin to outstrip the supply available from garden wells and springs. There was also an increasing demand for supply from industry, both for processing and for supplying condensing water for steam engines, together with a continuing demand for water to drive the existing mill wheels. Until this time the townspeople had relied on a number of dipping wells and pump wells. In 1803 trustees were appointed *for the purposes of providing a supply of water to the Town of Alloa from the proprietors of the Estate of Mar.*[78]

In 1820 the first grant of water from Gartmorn dam was made to the town, being conveyed by means of wooden pipes from the Gartmorn lade at Keilarsbrae to a reservoir on top of Hawkhill. The reservoir was not able to contain the water and a new filter bed was made at Keilarsbrae. An industrial supply was subsequently granted to Carsebridge Distillery, Keilarsbrae Spinning Mills, Gabberston Woollen Mills, Springfield Woollen Mills and to the Woollen Mill at Kilncraigs.[79]

In 1835 the Mar family leased out the coal workings to two groups of local business people, splitting the coal workings into two parts. The Collyland, Woodside and Devonside collieries were leased to the Bald family and the Alloa collieries eventually became the first Alloa Coal Company in 1836.[80] There was much discussion about supply of water to the town of Alloa at this time and, in 1877, the Earl of Kellie gave a grant of water to the town with a 38 year lease.[81] Filters and a water house were constructed at Jellyholme, along with new 12 inch pipe and extended coverage into the town of Alloa.[82] A supply of water was also obtained for the village of Sauchie from the filter beds and storage tanks to the west of Keilarsbrae mills. These works are mentioned as existing in the 1891 Alloa Water Act, where the details of compensation water are recorded[83] and are shown on the 1863 25 inch OS plans.[84] (Plate 2)

Between 1820 and 1894 the population of Alloa increased from some 3,000 to over 11,000 and by the end of that period there was a water famine in dry summers.[85] In 1891 an Act of Parliament established a public water supply from Gartmorn Dam and the dam was extended in 1894, increasing the size of the reservoir[86] (Plates 3-1 and 3-2) The Alloa Water Act, 1891 gives considerable information about pre-existing and planned water works and compensations volumes. Additional waterworks to the east of Forestmill collected more water for the lade. A compensation weir was built at Forestmill to ensure that at least 2 million gallons of water was released every 24 hours down the river Black Devon. The lade from Forestmill to Gartmorn reservoir was widened and deepened, the Gartmorn dam head was extended to 160 feet above Ordnance Datum and a new 40 foot wide overflow sluice was constructed. New filter beds were established at Jellyholme, feeding pipelines to Forebraes (to the NW of Alloa Hospital) and to Stirling Road (at the western boundary of the burgh). From these mains, pipelines were to be laid to enable the town of Alloa to be supplied with domestic, industrial and bulk purchase water.

Specific details were given of the bulk and compensation volumes required for existing users. Water supplies would continue to be made available from the lade at Keilarsbrae to Sauchie, Holton and the Whins areas. Particular mention is made of colliery water-powered pumping engines and supplies for the steam engines at collieries and the port at Alloa.

In every 24 hours a bulk supply of water was to be provided to the following premises at the rate of:-

Carsebridge Distillery	153,000 gallons
Keilarsbrae Spinning Mills *	200,000 gallons
Hallpark Woollen Mill	15,000 gallons
Gabberston Woollen Mills	15,000 gallons
Springfield Woollen Mills	15,000 gallons

* some could be sent to the Kilncraigs factory.

In addition, water from the lower section of the lade (from below the Pumpmill Pit at Sauchie) was to be available to Carsebridge Distillery at a rate of 4 million gallons every week from May to August and 8 million gallons every day from September to April, at not less than 500,000 gallons in each working day in a continuous flow. The distillery was obliged to return any unused water into the Brothie Burn. Together with supplies to other smaller factories, mines and steam engines it was calculated that the dam supplied about 1.4 million gallons per day to bulk and compensation users on top of 1.5 million gallons to domestic supply.[87] Lastly, the flow in the Brothie Burn opposite Gabberston Mill was to be maintained at not less than 60,000 gallons every hour between 5.00 h and 20.00 h, a minimum of 900,000 gallons per working day.[88]

A circular tower was constructed at the new Gartmorn dam head to regulate the 12 feet head of water from the dam. A pump house was built at the foot of

the dam head for a hydraulic pumping engine which raised the water up to a new service reservoir. This reservoir, settling pond, filter beds and a cottage for a waterman were established at the southern end of the dam head. A new pipeline was laid southwards past Clackmannan Station to the Tower Hill at Clackmannan where water was pumped up to a service reservoir to meet the domestic needs of the town of Clackmannan. The gas powered pump which lifted water from the base of Gartmorn dam to the service reservoir was constructed by the Glenfield Company of Kilmarnock and ran at 24 strokes per minute. It was eleven and one half inches in diameter and had a stroke of 30 inches, delivering 280 gallons per minute at a head of 34 feet.[89] This pump was powered by town gas [90] and was in use until the town of Clackmannan was connected to the Lossburn reservoir in the Ochil Hills at the beginning of the 20th century.[91] The building which had housed the pump became a visitor centre for Gartmorn Dam between 1980 and 1996.[92]

The dam, with a head of less than 100 feet, always provided a poor water pressure. In 1928, in order to meet the industrial and domestic demand, an electric pumping system was installed at Carsebridge to boost up the daytime pressure.[93] In 1966 there was still a legal agreement to provide Carsebridge distillery with 571,000 gallons a day and Patons and Baldwins (Kilncraigs Mills) with 150,000 gallons a day. In 1994 a new filter house was established at Jellyholme by Central Regional Council.[94] This provided a secure supply but by 2000 it had been closed over the summer months by algal blooms.[95] In 2004 a new waterworks was established at Jellyholme by East of Scotland Water.[96] Opencast coal workings in the catchment area of the reservoir caused water contaminated with fine clay to enter the dam, blocking the filters and ending the use of Gartmorn reservoir as a public water supply. The Jellyholme water works were finally sold off in 2008.[97]

When the problem with the water supply was identified, the water to the lade was turned off at the weir at Forestmill. Sadly, the weir is now in a state of disrepair and, as the water supply was never reconnected, the lade is now a dry bed, slowing filling with leaf mould This has led to Gartmorn Dam being supplied only by surrounding springs and field drains and presents a grave danger to its condition and status as an SSI.

Conversion Table

The historical sources quoted use a complicated mixture of Scots and Imperial weights, measures and volumes. The table below gives conversions to metric equivalents.

Weights:

Chalder: Varies, but locally in the Firth Estuary area for coal roughly equivalent to 30 cwts, converts to 1.53 tonnes.

Ton: Equivalent to 20 cwt, converts to 1.02 tonnes

Cwt: (hundredweight) Converts to roughly 50.8 kilogrammes.

Length:

Fathom: Equivalent to 6 feet, converts to 1.83 metres.

Yard: Equivalent to 3 feet, converts to 0.92 metres.
Mile: Equivalent to 1,760 yards, converts to 1.61 kilometres.
Volume:
Gallon: Equivalent to 8 pints, converts to 4.55 litres.

Glossary

Adit: A tunnel driven at a very slight slope upwards into the side of a valley to meet a coal seam, providing drainage for the seam above that point.
Bell Pit: A shallow shaft sunk into a coal seam close to the surface and coal removed around the base of the shaft to give a 'Bell' shape.
Chalder: A dry measure originally used for measuring grain. Its use as a weight varied with time and place, Locally in Clackmannanshire in 1791 it was the equivalent of 30 cwt of coal – *6 chalders or nine tons* (Old Statistical Account, 1791, Volume 9, Parish of Alloa, page 680.) and again in 1841 *a chalder waggon containing 30 cwts* (of coal), (New Statistical Account of Scotland 1845, Volume 8, Parish of Alloa, page 31.)
Compensation Water: The volume of water negotiated to be released into a river or stream to cover existing legal rights.
Day-Level: see adit.
Fairm Toon: Up to the early 19th century in this area a collection of houses for tenant farmers working collective land holdings.
Filters: Ponds filled with a carefully graded, different sized mixture of rocks (on the base) and sand (on top) through which water was filtered to remove sediment.
Fire Engine: In the 18th century, a steam engine.
Gauge Weir: low construction across a river with a narrow rectangular area inserted (often within a metal plate) to accurately measure minimum low.
Gin: A machine, powered by men, horses or water to provide power for driving other machinery.
Lade: An open, very gently sloping ditch carrying water to a water wheel.
Lint Mill: Lint was the Scottish term for flax. The lint mill, originally powered by water, separated the fibres of the flax before it was heckled (combed) and then spun into thread for weaving.
Multures: A portion of grain retained by a corn miller as payment for the use of the mill.
Pound Scots: Introduced in the 12th century, it was matched with the Pound Sterling of England in 1603 and finally replaced by the Pound Sterling in 1707 at a rate of twelve Pounds Scots to one Pound Sterling.
Pow: The narrow, tidal part of the lower reaches of a river entering the Forth estuary which provided a sheltered harbour for early, shallow draft sailing ships.
Run-rigg: (also called "ridge and furrow) An early method of ploughing by oxen on land requiring draining. A series of long narrow ridges was created by throwing up soil from interspersed ditches. The distance between the top of the rigg (ridge) and the bottom of the run (furrow) was such that a person sitting in one run could not see someone sitting in the next. The width of the rigg was usually only several metres. The practice was abandoned with the introduction of field drains.
Serfs: Individuals legally owned by a proprietor of an estate, mine or quarry. Their children also became the property of the proprietor. Serfs could be sold as part of the estate. Servitude in collieries in Scotland was not ended until 1799.
Sinke: A vertical shaft sunk to reach a mineral seam.
Snuff: A powdered form of tobacco, a pinch of which was inhaled through the nostril.
Waggon Ways: A narrow gauge railway line, originally made entirely of wood, then cast iron, which enabled horse drawn wagons to carry coal from the pits to the harbour.

In its latter stages there was a substantial network of these lines connecting the Clackmannan and Alloa collieries to Clackmannan Pow, Alloa Harbour and many coal using industrial premises.

Weir: A wall across a river raising the height of water in the river in order to get it to flow into a lade.

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The Gartmorn Lade System, Plate 1. Section of General William Roy's "*General Survey of Scotland*", 1747-55. © The British Library Board (Maps K.Top.48.25-1.a-f.) The Hultone "Water Engine" is shown in the top left corner and "Gartmoren dam" in the top right.