

# The First Railway Projects

## Introduction

This paper does not seek to analyze the problem of inaccurate estimates and poor project cost control identified in *Cost Overruns on Early Canal & Railway Projects*<sup>1</sup>, rather its focus is to look at some of the earliest railway projects constructed in the United Kingdom (UK). These were horse drawn wagonways used to transport ore and coal within the mines and onwards to other means of transportation. Where possible the contractual and management processes used in their construction will be identified<sup>2</sup>.

The focus of this paper is on the evolution of railways prior to the introduction of steam powered locomotives. Later developments are discussed in:

- *Myths and Legends The Origins of Standard Gauge Railways*<sup>3</sup>, and
- *Cost Overruns on Early Canal & Railway Projects*<sup>4</sup>.

Prior to the development of wagonways, the use of traditional wagons, or pack horses, to transport heavy materials across unformed roads and tracks was both slow and expensive. Wet weather turned the roads into seas of mud making the situation worse, as well as annoying local landowners as the width of the track spread wider, and wider, as horses and wagons tried to avoid the deepest of the mud.

The use of wagons running on rails mitigated these problems and improved the efficiency of the transportation by allowing one horse to deliver between 10 to 13 tons of coal per run, an approximate fourfold increase over road wagons. The efficiency of the wagonways improved as the technology improved, although there were many competing and parallel developments in the way wagonways were constructed.

## Early railway developments

The use of rails or groves to guide wagons of various sizes is very ancient technology. One of the earliest examples is the *Diolkos*, a paved trackway used to transport boats across the Isthmus of Corinth in Greece from around 600 BC, until the 1st century AD. The wheeled vehicles used to carry the boats ran in grooves cut into a limestone trackway<sup>5</sup>. Another early example is an inclined elevator that was built in 1504 (possibly 1495) on the east side of the Festung Hohensalzburg fortress in Salzburg, Austria<sup>6</sup> to keep the fortress supplied with food. Carts were hauled up, and lowered down, wooden rails by a winch at the top.

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<sup>1</sup> For a discussion on the cost issues experienced on railway projects at the start of the industrial revolution see *Cost Overruns on Early Canal & Railway Projects*:

[https://mosaicprojects.com.au/PDF\\_Papers/P207\\_Canal+Wagonway\\_Cost\\_Overruns.pdf](https://mosaicprojects.com.au/PDF_Papers/P207_Canal+Wagonway_Cost_Overruns.pdf)

<sup>2</sup> To see the events discussed in this paper in a comprehensive historical timeline download *Project Management - A Historical Timeline*:

[https://mosaicprojects.com.au/PDF\\_Papers/P212\\_Historical\\_Timeline.pdf](https://mosaicprojects.com.au/PDF_Papers/P212_Historical_Timeline.pdf)

<sup>3</sup> See: [https://mosaicprojects.com.au/Mag\\_Articles/AA016\\_The\\_Origins\\_of\\_Standard\\_Gauge\\_Railways.pdf](https://mosaicprojects.com.au/Mag_Articles/AA016_The_Origins_of_Standard_Gauge_Railways.pdf)

<sup>4</sup> See: [https://mosaicprojects.com.au/PDF\\_Papers/P207\\_Canal+Wagonway\\_Cost\\_Overruns.pdf](https://mosaicprojects.com.au/PDF_Papers/P207_Canal+Wagonway_Cost_Overruns.pdf)

<sup>5</sup> The Diolkos was not the first use of groves to guide wagon wheels, but it does appear to be the first built example, earlier occurrences were carved into bedrock, see: *The Diolkos - The first truly commercial project?*:

<https://mosaicprojects.wordpress.com/2023/04/17/the-diolkos-the-first-truly-commercial-project/>

<sup>6</sup> See: <https://www.funimag.com/funimag10/RESZUG02.HTM>



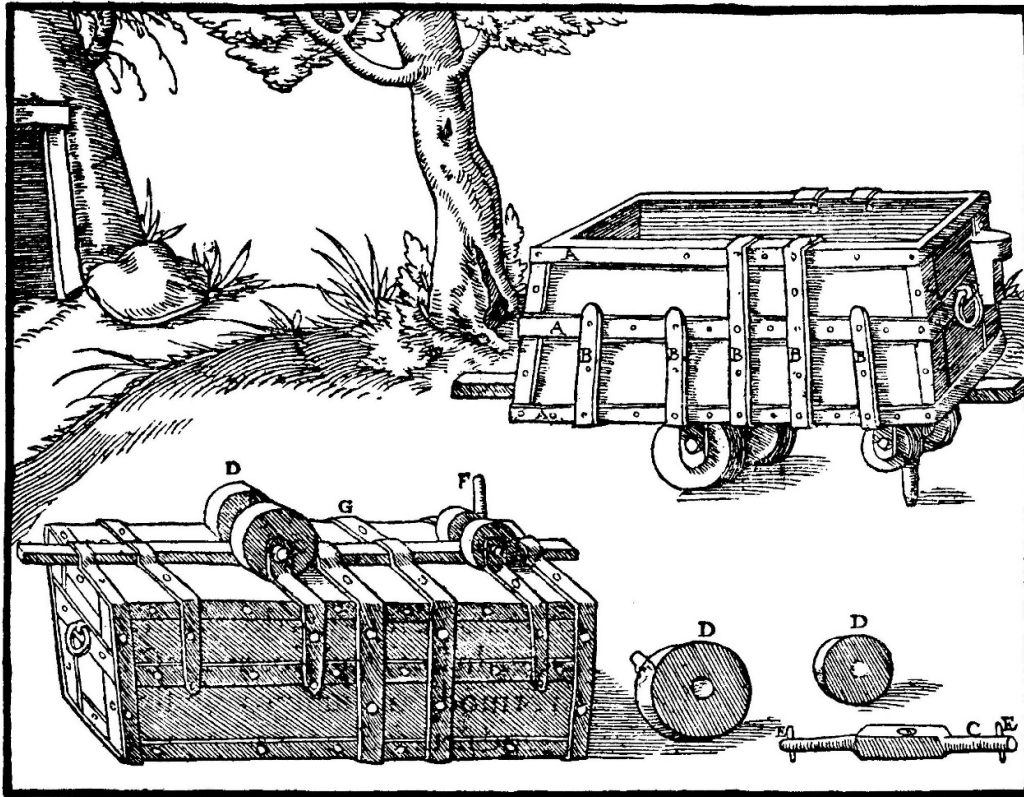
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The concept of wagonways used in this paper focuses on mining, wheeled tubs on wooden rails were used in mines in Germany, Alsace, and Lorraine from as early as early as the fifteenth century. One type of guided wagon, *Hund carts*, were in use by miners before the 1550s, to facilitate the transportation of ore in from within the mine to the surface. An example of their operation was illustrated by Georgius Agricola in his 1556 work *De re metallica*. The *Hund carts* he described had unflanged wheels running on rails made of wooden planks with a vertical pin on the cart fitting into the gap between the two planks to keep the *Hund* on the rails. A line of connected carts could be pulled by a horse to transport the ore.

The *Reisen* was a parallel development that occurred around the same time period if not earlier, it used narrow rails and flanged wheels. *Hund carts* appear to be used primarily underground, *Reisen* for transporting ore above ground. There are numerous references to these types of wagonway in central Europe in the 16th century.

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BOOK VI.



Minecart shown in *De Re Metallica* (1556). The guide pin 'F' fits in a groove between two wooden planks.

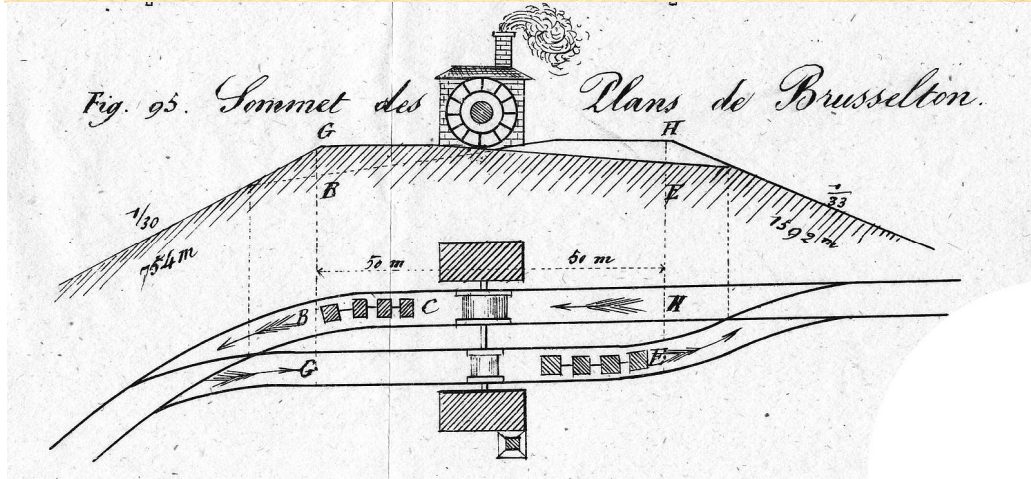
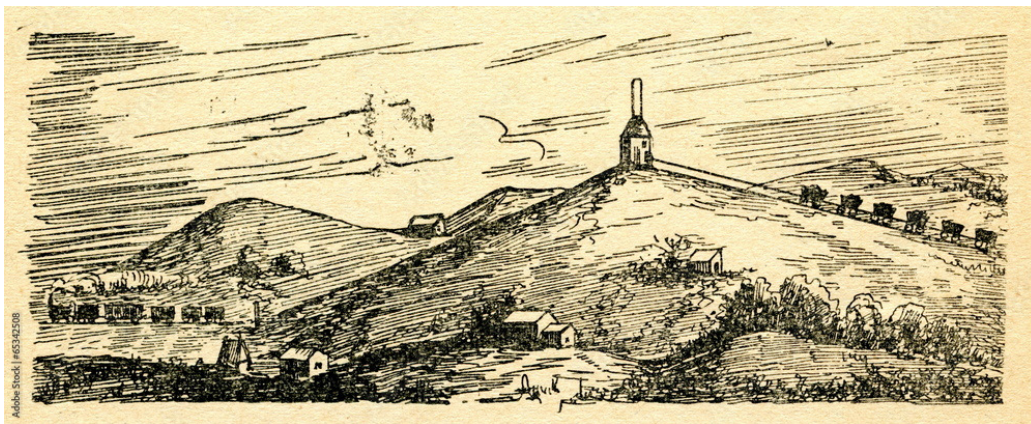
The use of wagonways appears to have been introduced to England by German miners working for an Anglo-German company, the *Company of Mines Royal*, that was established as a State monopoly by Elizabeth 1 in 1564 to prospect for, and mine, copper<sup>7</sup>.

<sup>7</sup> *The Discovery and Excavation of the Willington Waggonway*, R. Carlton, A. Williams. p15:  
[https://mosaicprojects.com.au/PDF\\_Papers/P207\\_The\\_Willington\\_Waggonway.pdf](https://mosaicprojects.com.au/PDF_Papers/P207_The_Willington_Waggonway.pdf)

## Wagonway technology

Most wagonways constructed in the UK were derived from the *Reisen* concept. Typically, they were designed to carry fully loaded wagons downhill to a canal or boat dock, and then return the empty wagons back to the mine<sup>8</sup>. As far as practical they were designed with a smooth gradient from end-to-end which involved building cuttings, embankments, culverts, bridges, and occasionally tunnels. For the most part, a brakeman controlled the decent of the loaded wagons and horses were used to pull the empty wagons back to the mine. Where this could not be achieved, horses pulled the wagons on flat terrain, and winding gear or other assistance was provided on the more steeply sloping section.

One example of the use of winding gear was at the Brusselton Incline on the Stockton to Darlington railway. This line was built as a wagonway in 1825, and for most of the distance either horses or early steam trains provided the pulling power. The problem was a steep ridge near Brusselton, this obstacle was managed by a stationary steam engine using hauling ropes to winch a set of wagons up one side, and simultaneously lower another set down the other side<sup>9</sup>.



Note: the different size winding wheels were to allow for the different slope lengths.

Different sizes of winding drum were used to compensate for the different length of slope on either side of the ridgetop, and a fail-safe system was developed to stop wagons running away in the event of a rope

<sup>8</sup> See: <https://dogedaos.com/wiki/Wagonway.html>

<sup>9</sup> See: <https://brusseltonincline.group/>



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breaking. Despite these technical innovations, few years later a tunnel was dug through the hill and the incline was abandoned.

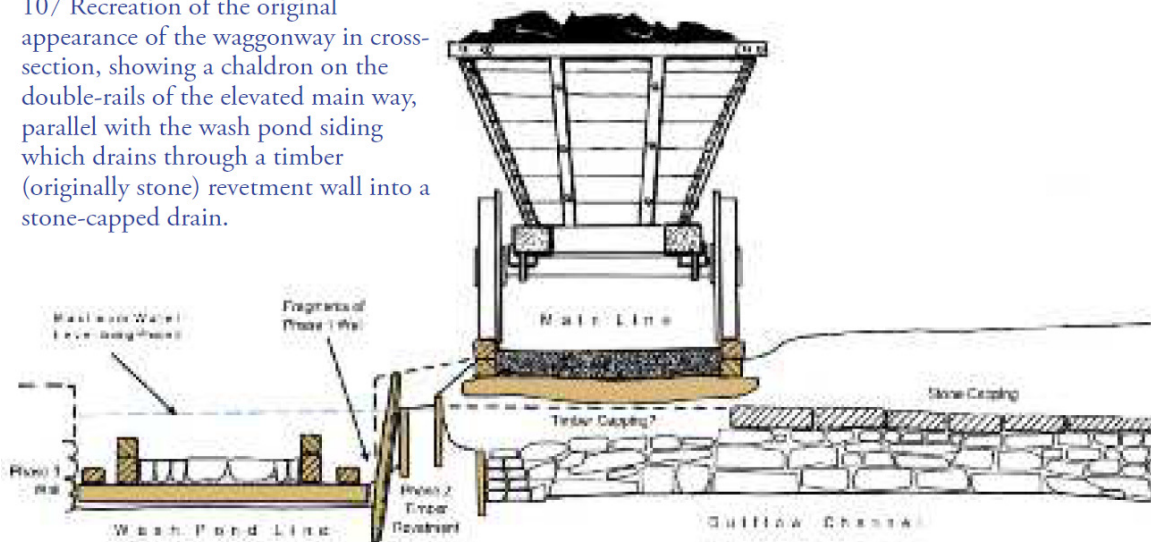
### Wagonway rails

The earliest wagonways were built from wood, the rails were a few inches wide and were fastened down, end to end, on logs of wood, or sleepers, placed crosswise at intervals of two or three feet. The wagon wheels were also made from wood and were flanged to keep them on the rails.



Parts of the Willington Waggonway constructed in 1795 (under excavation in 2013).

107 Recreation of the original appearance of the waggonway in cross-section, showing a chaldron on the double-rails of the elevated main way, parallel with the wash pond siding which drains through a timber (originally stone) revetment wall into a stone-capped drain.



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One example of the use of wooden rails was the Willington Waggonway constructed in 1795<sup>10</sup> sections of this wagonway were excavated in 2013 and showed a high level of sophistication in the minimization of the energy needed to transport coal, including a wheel wash to clean the carts (called 'chaldrons') before the return trip to the mine.

Over time, it became a common practice to cover the wooden rails with a thin plate of iron, in order to extend their life. But the plating caused more wear on the wooden wheels of the wagons, and towards the middle of the 18th century led to the introduction of cast iron wheels, one early use being recorded on a wooden railway near Bath in 1734. Then over time it was found the iron sheathing was not strong enough to resist buckling under the passage of heavily loaded wagons, so rails made wholly of iron were developed.

In 1767, the Coalbrookdale Iron Works cast a batch of iron rails or plates, each 3 ft (1 m) long and 4 in (100 mm) broad, having an upright ledge or flange on the inner side to keep the flat wheels of the wagons on



the track. This type of 'L' shaped rail became known as a plateway; a person employed in laying and maintaining railway track in the UK is still called a platelayer.

Initially wooden sleepers continued to be used to support the rails, but from around 1793, stone blocks also began to be used on some wagonways<sup>11</sup>.

The image is a replica of a "Little Eaton Tramway" wagon. The rails are supported on stone blocks, have an 'L' cross-section, and the wheels have no flange.

Another form of iron rail, the edge rail, was first used by William Jessop on a line which

was opened between Loughborough and Nanpantan in Leicestershire in 1789. This line was originally designed as a plateway, but objections were raised to rails with upstanding flanges being laid on the turnpike road that formed part of the route, this difficulty was overcome by paving, or causewaying, the road up to the level of the top of the rail and using flanged wheels. This type of railway is known as an edgeway and is similar to modern train and tram tracks.

These two systems of constructing iron railways, the "L" plate-rail and the smooth edge-rail, continued to exist side by side until well on into the 19th century. The advantage of plate-rails was the wheel spacing on wagons was not critical, this was particularly useful on public railways accessed by paying a toll, and where different wagon owners would inevitably have slightly different wheel gauges on their wagons. Public plateways included the Lake Lock Rail Road built near Wakefield, West Yorkshire, and opened in 1798 and the Surrey Iron Railway (SIR), from Wandsworth to West Croydon opened in 1803.

The advantage of edge-rail over a plate-rail was keeping the rails free of rocks and debris. The edge-rail simply allowed stones to fall off but maintaining a consistent wheel gauge on all of the wagons was critical.

Over time the length of the rails increased and the metallurgy improved allowing for heavier wagons and eventually the introduction of steam locomotives. Steam power was initially used to replace horses for hauling coal and ore, but quickly transforming into the modern steam powered railways of the 19<sup>th</sup> century.

<sup>10</sup> *The Discovery and Excavation of the Willington Waggonway*, R. Carlton, A. Williams. p30 & 61  
[https://mosaicprojects.com.au/PDF\\_Papers/P207\\_The\\_Willington\\_Waggonway.pdf](https://mosaicprojects.com.au/PDF_Papers/P207_The_Willington_Waggonway.pdf)

<sup>11</sup> See: <https://academickids.com/encyclopedia/index.php/Wagonway>



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The key innovation in rail technology was the invention wrought iron rails, by John Birkinshaw in 1820 at the Bedlington Ironworks, in Blyth Dene, Northumberland. Wrought Iron rails could be mass produced, which triggered the railway age, with their first major use being in the Stockton and Darlington Railway opened in 1825, about 45 miles (72 km) to the south.

### A selection of wagonways

During the wagonway period, each line was independently owned and built for a specific purpose, usually transporting goods, coal or other quarried materials to a wharf. There was no concept of networking and so every line used a gauge that suited its owner's requirements and local conditions. The standardization of rail gauge did not occur until after the introduction of steam locomotives and the beginnings of a rail network, for more on this see: *Myths and Legends: The Origins of Standard Gauge Railways*<sup>12</sup>.

Possibly the first wagonway in the UK was built at Prescot, near Liverpool, sometime around 1600, possibly as early as 1594. Owned by Philip Layton, the line carried coal from a pit near Prescot Hall to a terminus about half a mile away<sup>13</sup>.

A few years later, probably sometime before 1604, a funicular railway<sup>14</sup> was built at Broseley in Shropshire. This carried coal for James Clifford from his mines down to the River Severn to be loaded onto barges and carried to riverside towns<sup>15</sup>.

The **Wollaton Wagonway** appears to be the first wagonway to cover a significant distance, it built between October 1603 and October 1604, in the East Midlands of England by Huntingdon Beaumont in partnership with Sir Percival Willoughby. This wagonway cost £172 to build. As with most early wagonways, the wagons were drawn by horses along wooden rails, using a flanged wheel to keep the wheels on the rails. This wagonway ran for approximately 2 miles from the Strelley mines to Wollaton Lane End, from where most of the coal was taken onwards by road to Trent Bridge and then downstream on the river Trent by barge. The mine was only worked until about 1620, after which the wagonway was presumably abandoned<sup>16</sup>. However, the success of the Wollaton Wagonway led to Huntingdon Beaumont building wagonways for his other mining leases near Blyth in Northumberland. Other mine owners saw the commercial benefit of wagonways and the concept rapidly spread<sup>17</sup>. The continuous evolution of railways can be traced back to the Wollaton Wagonway.

Probably the oldest railway in continuous use is the **Tanfield Railway** in County Durham, England. This began life in 1725 as a wooden wagonway worked with horse power and developed by private coal owners.

<sup>12</sup> Download *Myths and Legends: The Origins of Standard Gauge Railways* from:

[https://mosaicprojects.com.au/Mag\\_Articles/AA016\\_The\\_Origins\\_of\\_Standard\\_Gauge\\_Railways.pdf](https://mosaicprojects.com.au/Mag_Articles/AA016_The_Origins_of_Standard_Gauge_Railways.pdf)

<sup>13</sup> Jones, Mark (2012). *Lancashire Railways – The History of Steam*. Newbury: Countryside Books. p. 5. ISBN 978-1-84674-298-9. This wagonway has not been positively identified.

<sup>14</sup> A funicular railway system is characterized by two counterbalanced carriages (also called cars or trains) permanently attached to opposite ends of a haulage cable, which is looped over a pulley at the upper end of the track. The result is that the two carriages move synchronously: as one descends, the other ascends at an equal speed. The weight of coal being moved down to the river creating the energy to power the system:  
<https://en.wikipedia.org/wiki/Funicular>

<sup>15</sup> Peter King, *The First Shropshire Railways* in G. Boyes (ed.), *Early Railways 4: Papers from the 4th International Early Railways Conference 2008* (Six Martlets, Sudbury, 2010), pp. 70–84. A funicular railway operates on a relatively steep slope with the movement of wagons up and down the slope controlled by some form of winding gear.

<sup>16</sup> See: [https://www.island-publishing.co.uk/WRC\\_mirror/woll\\_wag\\_leaflet\\_a4.pdf](https://www.island-publishing.co.uk/WRC_mirror/woll_wag_leaflet_a4.pdf)

<sup>17</sup> For details of some of the wagonways, that have been archeologically studied see: *The Discovery and Excavation of the Willington Wagonway*, R. Carlton, A. Williams. p16 - 28  
[https://mosaicprojects.com.au/PDF\\_Papers/P207\\_The\\_Willington\\_Wagonway.pdf](https://mosaicprojects.com.au/PDF_Papers/P207_The_Willington_Wagonway.pdf)



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By the mid-19<sup>th</sup> century, the line had converted to standard gauge track with iron rails and steam powered locomotives. It continues in operation as a heritage line.

The original Tanfield Wagonway was built by the Grand Allies, an association of coal-owning families, including the Bowes, Liddells, Ords, and Montagues, who joined together in the 1720s to overcome difficulties in obtaining wayleave to transport coal from their mines to wharfs on the River Tyne. The wagonway solved this problem economically, and from the wharfs on the River Tyne, the coal was transported in keels<sup>18</sup> downriver to Shields, then transferred to colliers (bulk coal carrying ships) for the voyage down the North Sea coast to London and the south east of England.



In addition to the loading facilities, the wagonway required some major engineering works, including the Causey Arch and Causey Embankment. The Causey Arch is the world's oldest purpose-built railway bridge. Built in 1725–26 the bridge was designed and constructed by local stonemason Ralph Wood for a fee of £12,000.



When built, it was the longest single-span bridge in the country with an arch span of 31 meters (102 ft), a record it held for thirty years. It is reported that Wood was not confident in the bridge's design. He was

<sup>18</sup> **Keel:** a tubby craft, rounded fore and aft, with a single large square sail of ancient design:  
<https://co-curate.ncl.ac.uk/keels-historical-account/>

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fearful that this stone arch would not last and took his own life at the bridge. However, the bridge has stood intact for nearly 300 years and is the oldest surviving single-arch railway bridge in the world.

During the first years of its use, up to 930 horse-drawn timber wagons crossed the bridge daily in each direction — or one wagon every 20 seconds and only about 45m between each one which would have required some careful traffic management. At its busiest, the wagonway carried some ½ million tons coal per year<sup>19</sup>.

The Causey embankment was also massive, this image was taken 200 years after its initial construction when the line was being used by the North Eastern Railway.



<sup>19</sup> See: <https://www.atlasobscura.com/places/causey-arch>

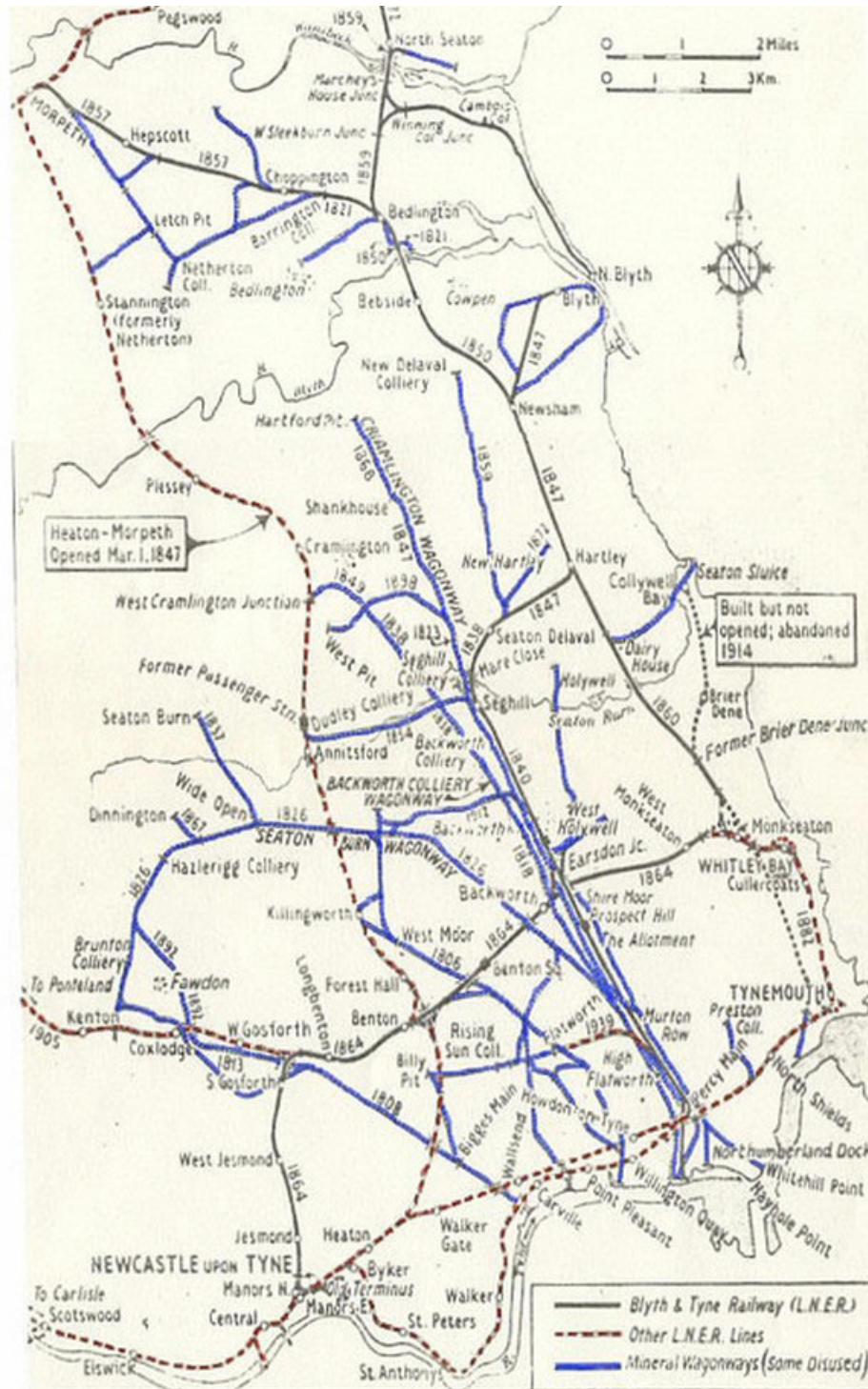




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## Summary

The total length of wagonways built in the 17<sup>th</sup> and 18<sup>th</sup> centuries is difficult to determine. Extensive networks were built in South Wales (some 150 miles of plateway) and Northumberland (see blue lines on map below), but there were also many other lines in locations ranging from Scotland to London via Bristol.



The development of the railways based on Percy Main



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Generally, wagonways were built in areas where canals were not viable due to the terrain or the cost of a canal was not warranted due to the relatively short life of the mine.

As discussed in *Cost Overruns on Early Canal & Railway Projects* (page 9)<sup>20</sup> the start of the steam powered railway network in the UK began with the replacement of horse power with primitive steam power on some wagonways in 1812/13, this quickly led to the development of wagonways that were built for steam power locomotives and then by 1830, the construction of railway lines between cities<sup>21</sup>.

The construction of 1000s of miles of railway track followed, for more on the continuation of the development of railways in the UK see: *The development of the railway network in Britain 1825-1911*, by Leigh Shaw-Taylor and Xuesheng You<sup>22</sup>.

As steam powered railways became the dominant means of transporting goods from the 1840s onward, the vast majority of mines still operating built branch lines from the main line tracks into the mine, often using the routes pioneered by their wagonways and the concept of the wagonway faded into history.

## Conclusions

The construction of wagonways changed the economics of moving coal and other minerals from the mines to a suitable location for onward shipping. The cost savings over traditional transport were massive justifying the construction and maintenance costs. More significantly, the engineering know-how developed on the wagonways, underpinned the rapid development of railways as soon as efficient steam powered locomotives became available. The rate of technological change in the period from 1810 to 1840 was truly incredible!

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<sup>20</sup> Download *Cost Overruns on Early Canal & Railway Projects* from:

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<sup>21</sup> The primary purpose of early railways was freight (primarily coal), but many also carries passengers from early in their operation. For more on the first passenger railways see *Where were the first passenger railways built?*:

<https://mosaicprojects.wordpress.com/2023/04/25/where-were-the-first-passenger-railways-built/>

<sup>22</sup> Download *The development of the railway network in Britain 1825-1911*:

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