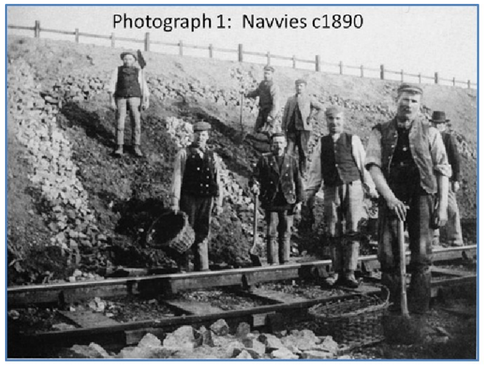
The need for earthworks—and the "Navvies"

Trains are an efficient form of transport partly because there is relatively little friction between the wheels and the rails. Low friction, however, means that trains can't climb steep slopes as the wheels slip on the rails. For this reason, the Permanent Way has to be made as flat as possible and requires the construction of embankments and cuttings to overcome the natural contours of the land.


Photograph 1: Navvies c1890

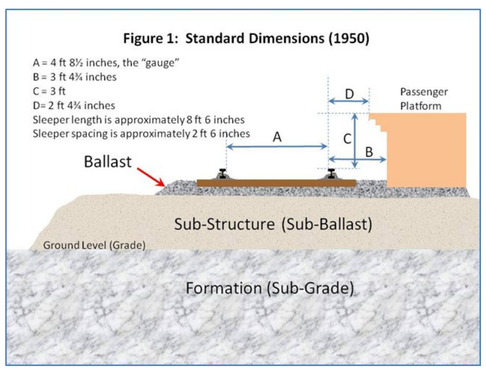
About the time our line was built in the 1860s, there were few mechanical aids so the embankment on which you are standing was almost certainly built through hard manual labour by workmen called "navvies". Navvies took their nickname from the workers who, in the 18th century, had built the canals – they were known as "navigators". This nomadic army of workers were immensely strong, often unruly, and had a reputation for hard drinking. It has been estimated that during one working day each man had to hoist the equivalent of 20 tons (20,320 kg) of material to a height of 6 ft (1.83 m).

Despite the hard work, men were attracted to the railway as it paid better than farm work; wages were between 15/- (75p) & 22/6d (£1.12½) per week. This often left farmers short of manpower.

Constructing the track bed

Figure 1 shows the structure and dimensions of the track and track bed. It is based on the 1950 standard but its origin goes back to the early days of railway construction.

Ballast is used to give support, load transfer and drainage to the track. It must support the weight of the track and of passing trains. Ballast is made up of crushed granite or a similar material and should be rough in shape so the stones can interlock and reduce movement. It is usually laid to a depth of 9 to 12 inches (228 to 305 mm). We have used ballast with smooth edges; this would not have worked quite as well as crushed granite but has been recovered from the original line.



In restoring our site, we have found that the track bed (sub-structure) is almost entirely composed of compacted, smooth gravel. Whether it comprises the entire embankment is hard to tell, but we do know that the area around Wheathampstead is rich in gravel that was deposited here during the Ice Age and that engineers used it extensively for building railways.

The Permanent Way consists of rails, sleepers, fastenings, ballast, substructure and formation or sub-grade, as shown in Figure 1.

To give passengers a comfortable ride, the rail alignment must be very accurate. Designing and constructing track is a complex engineering activity involving earthworks, steelwork, timber and suspension systems.

Track gauge

A popular legend traces the origin of the 4 ft 8½ inch (1,435mm) gauge to the distance between Roman chariot wheels, as measured from the ruts in Roman roads. The distance between the wheels of horse-drawn carts was measured from the outermost edges of the wheel rims but it became clear that, for trains, it was better to have wheel flanges on the inside of the rail. Thus, the railway track gauge is the distance between the two inside faces of the rails.

Early railway engineers couldn't agree on the best distance between the rails. The railway pioneer George Stephenson and his son Robert chose as their standard the 4 ft 8½ inch gauge used for horse-drawn coal wagons. However, when Isambard Kingdom Brunel built the Great Western railway in the 1830s, he chose a gauge of 7 ft ¼ inch (2,140 mm). Parliament adopted the narrower Stephenson gauge in 1846. It took the Great Western 42 years to convert to the now "standard" gauge. Today approximately 60% of railways around the world (including high-speed railways) use the British standard gauge.

Our thanks

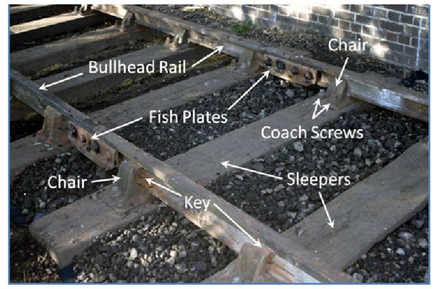
We are grateful to BAM Nuttall, who have converted the section of rail beyond Luton into a guided busway, for donating the materials used in this restoration.

The track

Track consists of the two steel rails, secured on sleepers so as to keep the rails at the correct distance apart and capable of supporting the weight of trains. Sleepers are spaced at 30 inch (760 mm) intervals..

Sleepers are usually made from softwood such as pine, impregnated with preservative and, under good conditions, will last up to 25 years. They are easy to cut and drill and, when our railway was constructed, would have been cheap and plentiful. Nowadays, other types of materials are used, notably concrete and steel.

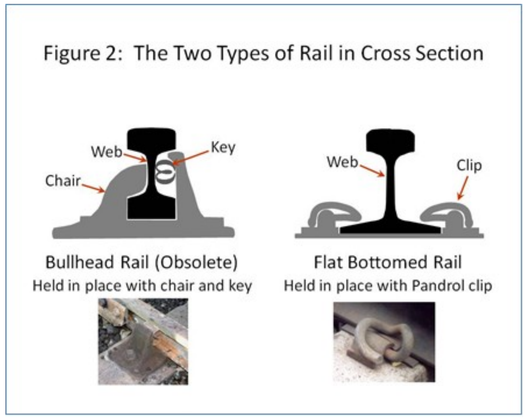
Photograph 2: Naming of Parts



Photograph 2 shows the main features of traditional track that has been in use since Victorian times and can still be seen on our rail system today.

Originally, track sections were joined together with fishplates and a gap was left between the sections to accommodate expansion in the heat. It was this gap that generated the rhythmic "clickety-clack" noise heard by passengers. Modern track is welded in 60 foot sections and fixed to concrete sleepers so expansion joints are only required after a mile (1.6 km) or more and rail noise is significantly reduced.

There are two main types of rail: Bullhead and Flat Bottomed (Figure 2). As shown in Figure 2, Bullhead rail is mounted in a special "chair" made of cast iron and secured by a "key" wedged between the rail web and the chair. Keys were sometimes made of wood and our short section has one wooden key. The chairs are secured to the sleepers by "coach screws". Bullhead rail was originally designed with reuse in mind. The intention was that it would be turned over when the top had worn but this proved impossible because the underside also wore where it had been secured to the sleeper via the "chair".



Laying track is heavy work. Each of the four sections of our length of rail weighs in at well over a quarter of a ton. The cast iron chairs each weigh 53 lbs (24 kg). The project team built this short section of track (total weight: 3 tons) by hand. We have a real feel for what it was like to be a 19th century navvy!