THE WOLGAN VALLEY RAILWAY.

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My first connection with this work was at the end of April, 1906, when Mr. D. A. Sutherland, Consulting Engineer and General Manager of The Commonwealth Oil Corporation, Ltd., asked me to take charge of the survey and construction of the proposed line of railway.

I found that some surveying had already been carried out, consisting of a trial-line, for which too little time had been allowed, and therefore insufficiently worked up, between Clarence Siding and the northern end of a long ridge or spur, overlooking the Wolgan Valley, at a point where the mining of shale had already been commenced. For the connection between the top of the spur and the valley, it had been proposed to construct a rope incline. The terminus of the railway proper would thus have been at a high level, about 1200 feet about the Wolgan River.

The question as to whether this was the best scheme to adopt, or whether it would not be better to take a locomotive line right down into the valley if it could be managed, had not been settled when my services were called into requisition. There was also the question of gauge to be decided upon.

Mr. Sutherland was strongly in favour of a locomotive line into the valley, and I fully agred with him, and the practicability of laying out and building such a line was the first problem to be solved, because if it could not be managed, or if the cost was prohibitive, no further time or effort should be wasted on it. This problem was not an easy one to tackle. Those who know the Blue Mountain region, are aware that its valleys and gorges are hemmed round by a generally precipitous wall of cliffs, often 300 to 500 feet high; and it is only here and there that a break away occurs, by means of which access from the top to the bottom or "vice versa" can be obtained.

This is particularly the case in the Wolgan Valley, the inaccessability of which led to its use in former days for extensive cattle-duffing.

The services of Mr. George Marshall, formerly of my staff in the Railway Construction Branch, and who had also had much valuable experience in South Africa, had already been secured, and he was trying to negotiate a somewhat promising descent into the valley with ten chain curves and 1 in 40 grades.

Mr. Sutherland gave me authority to add to the survey staff, and engage additional surveyors, and finding that the number employed was altogether inadequate, I took steps to strengthen it.

The new surveyors included Mr. Thom, who had previously held an appointment under me in the Department of Works; Mr. Rhodes, who had been also on my staff in that Department, and was now placed in charge of the survey work for the first 19 miles, and Mr. Amphlett, who was told off to assist Mr. Marshall.

The previous survey, which had been run by Mr. Cardew, M. Inst. C.E., junctioned with the Western Line at Clarence Siding. This point, which naturally suggested itself at first on account of its being at an existing and well-established railway station, was, on investigation, condemned, and I turned my attention to other points.

After trying the spot where Dargan's Creek crosses the Main Western Railway at 87 miles 45 chains, and from which it was possible to get a line to the top of the ridge, I found that the best point of departure was at 86 miles 70 chains, which is about 1½ miles back from Clarence. From this point a fairly continuous ascent was obtained without much difficulty, and the top of the ridge was reached 7 miles out. At this point, which proved to be the summit of the line, alternative routes presented themselves. A deviation off the main ridge had been suggested, along what was known as the Sunnyside route. By following this route the descent to the valley commenced, only a few miles out, while the other alternative, the line on which Mr. Marshall was engaged, left the main ridge only after 20 miles from the junction had been traversed.

It was clear, after some study of the problem, that the adoption of 5 chain curves, and 1 in 25 grades, was unavoidable. Mr. Thom was therefore instructed to work up the Sunnyside route under these conditions, while Mr. Marshall made renewed efforts with the so-called Penrose Creek route.

Mr. Thom carried out his work in a very capable manner, and obtained a good line; but as it proved to be considerably longer, and to pass through a good deal of private land, over which, under the older Mining Act, right to construct would not have been acquired without obtaining an Act of Parliament, preference was given to the one surveyed by Mr. Marshall. A great deal of work had to be done, and a vast amount of scheming carried out before a really practicable line was obtained. The gorge through which a great part of the descent had to be negotiated, was so narrow and the levels were so bound by the necessity of passing through certain spots, that many times the task seemed almost hopeless.

Of course, it must be understood that if economy had been no object, and that the construction of a main line, carrying an enormous traffic, were concerned, the difficulty could have been solved by the adoption of spiral tunnels, as on the St. Gothard Railway. In that case, it would have been possible to start cork-screwing down from the top of the ridge, inside the mountain, till the level of the valley was reached, when the line could have passed out into daylight. This method was, of course, out of the question.

To bring the line within the region of practicable cost, as mentioned above, a ruling grade of 1 in 25 was adopted, with curves of 5 chains radius. There was no possibility of compensating for curvature, and the 1 in 25 grades occur, therefore, on 5 chain curves, so that the actual ruling grade may be said to be 1 in 22.5, not 1 in 25. A study of plan and section, as well as an inspection on the ground, will show how rigid were the conditions of the problem.

As an example of the difficulties encountered, it may be mentioned that when after much trouble it was found possible to get down through the gorge, and out into the open valley, the level of the formation turned out to be at a height of 40 feet above the base of the cliffs, so that either the railway would have had to be carried on a high viaduct along the front of the cliffs, or it would have been necessary to keep it inside the tunnel, and so avoid the open altogether. Of these two alternatives, the latter would have been the only safe location. but it would have been too costly. The problem was attacked once more and, eventually, by lengthening the line, suitable levels were obtained. A tunnel of 20 chains length, however, was necessitated.

All this work and trouble involved the expenditure of much time. which may be shown by the fact that, although the survey of this part of the line was commenced in April, 1906, the final selection and location of the centre line, between 20 and 31 miles, was only just completed in advance of the earthworks in November, 1907.

The heaviest part of the line is situated between 20 miles and the bottom of the long grade, at 28 miles 40 chains; but there is very little of the rest that can really be classed under the category of light lines, and had it not been for the insertion of curves of small radius, the cost per mile throughout would have been very considerable.

I would like, here, to testify to the energy and ability displayed by Mr. Marshall, as also to give my warmest praise to Mr. Rhodes' efforts.

The steepest grade of 1 to 25 has been confined to the length between 19 and 29 miles, and I arranged that from the 19 mile peg, back to the junction, the ruling grade against the load should be 1 in 50 only. The result has been that two train loads, from Newnes to the station at 19 miles (which was named by Mr. Sutherland after me) can be there united, and be hauled by a single engine of the same power to the junction, or if considered more convenient for the one engine to take the same load from end to end, a higher speed can be obtained when traversing the distance from Deane to the Junction. From the junction towards Newnes, the loads would be generally light. It would not matter if some grades of 1 in 30 in this direction were inserted, and this was accordingly done from motives of economy.

Bound up with the whole question was that of gauge. Steep grades on a narrow gauge limit the load too much. It was anticipated that when the Company was in full swing, over 1000 tons of goods would have to be conveyed over the line. It was clear, therefore, the standard gauge must be adopted, especially as the Railway Commissioners had offered to lend their rolling stock if that gauge were not departed from. But how about the curvature, it will be said, was it not excessive? No. Not for the waggons, which were daily hauled safely over the Camden Railway, with its 5 chain curves; but what about locomotives? On the Western Line, curves of 8 chains radius were originally constructed, and had all been cut out because the wear of rails and flanges had been excessive.

This question had to be solved by looking to the practice of other countries. In New South Wales, the locomotives were too stiff. Some other type must be adopted.

During my trips round the world in 1894 and 1904-5 I studied this question, and the following observations will be of interest. I deal only with railways of a gauge of 4 feet 8½ inches, and wider, because the practice as regards narrower gauges would not help us.

In 1894 I found numerous curves of 16 degrees, equal to 5½ chain radius, one curve of 18 degrees, equal to 4.8 chain radius, and one of 22 degrees, equal to 4 chain radius, on the South Pacific Railway System in the Western United States, and these were traversed by 8-wheeled coupled American locomotives of the Consolidation type. This was rendered possible by providing two of the pairs of wheels with broad, plain treads in place of flanging them. The curves mentioned have now been cut out; but they were worked for many years.

In 1904, I travelled in a train on the main line of the Canadian Pacific Railway, where one curve of 3½ chain radius exists. All the Company's locomotives traverse this curve.

On some of the mining branches of the Canadian Pacific Railway, where curves of 5 chains and grades of 4½ per cent. equal 1 in 22.5 exist, Shay locomotives are used.

On the Tamalpais Railway, a scenic line in California, there are curves of 70 and 80 feet radius, the traffic being hauled by locomotives of the Shay type.

On the Kandy Railway in Ceylon, there are curves of 5 chains radius, the gauge being 5ft. 6in. These are negotiated by locomotives built by Kitson and Co., of Leeds. They are 6-wheeled coupled with bogie in front. The middle wheels have thin flanges; considerable play in the axle boxes is allowed, and the connecting rod and side-rod pins are barrel shaped, so as to permit of the rods working out of the straight line.

There are many types of locomotives designed for sharp curves. Recently, locomotives of the Mallet type, used for many years in Europe, have been built both by the American Locomotive Co. and the Baldwin Co., and have been received with favor.

Some of the leading locomotive builders of Great Britain have taken up the building of locomotives of articulated types.

The North British makes the Fairlie Engine, the design of which was first adopted for the Festiniog 2 feet gauge railway in North Wales.

Kitson and Co. make locomotives of the Meyer type.

Beyer and Peacock have recently built locomotives of a new type called the Garratt.

On the Continent of Europe, many types have been adopted to suit sharp curves, and the Swiss Locomotive Co., Maffei, of Munich, and several other well-known firms, build engines of the Mallet, Meyer. Hagans and other types.

The Hanoverian Locomotive Co., of Hanover, have introduced a new method called the Gölsdorf, consisting of a means by which the axles have considerable lateral play. That Company maintains that their 10-wheeled, coupled locomotives, fitted with this arrangement, traverse 5 chain curves with ease.

In view of the above facts, I had no hesitation in recommending the adoption of curves of 5 chains radius, and steep grades, and as I had been much impressed with the performance of the locomotives of the Shay type that I had seen, orders were given for locomotives of this design, to the Lima Locomotive Co., of Lima, Ohio, who make them.

The Commonwealth Oil Corporation now possesses three 70-ton locomotives and one of 90 tons has recently been imported, and may shortly be expected to be at work.

The Company have had built 19 bogie open-topped waggons of 32 tons capacity, one bogie covered waggon and five 5000 gallon oil tank waggons. There are also under order ten "D" waggons of 10 tons capacity, with extra large bodies, so as to carry full loads of coke.

METHOD OF CARRYING OUT THE WORK.

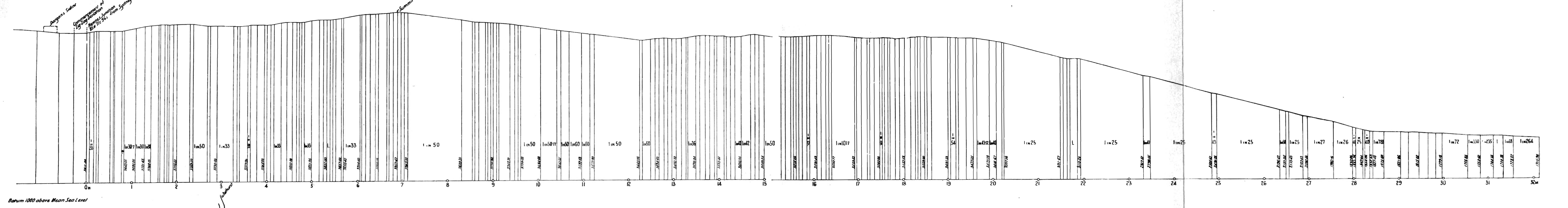
All the earthwork and permanent way and all other works and buildings except the engine shed and coal stage at the Junction have been carried out by day labour. A good staff of gangers and timekeepers were employed under the superintendence of Mr. J. D. Simpson, the Engineer-in-Charge, and the work has been well and economically carried out. Had it been decided to do everything by contract, much delay would have been sustained, as it is essential, before letting a contract, to have all the setting out complete, as well as all specifications and contract drawings. From the nature of the case, it was impossible to wait for these.

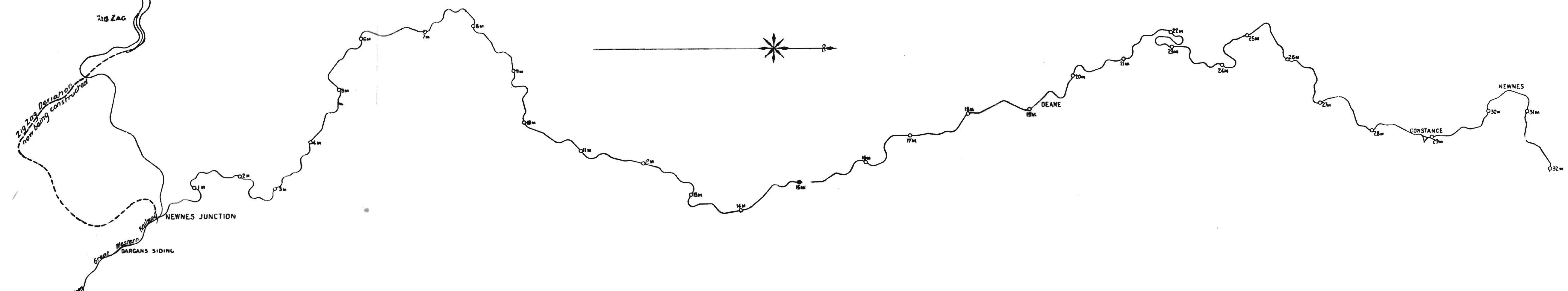
In accordance with the practice on the New South Wales Railways, all curves have been transitioned at the ends and the centre lines has either been laid out at the outset with transition curves, or the ends have been afterwards adjusted by slewing the tangents so as to permit of the insertion of the modified curve. The former method was adopted on Mr. Marshall's length, the latter on Mr. Rhodes'. The former is the one that has been generally adopted in the Works Department, under conditions where there has been sufficient time for completing the pegging out, but the latter method I have found to possess very considerable advantages, and I believe to be simpler and more economical as to time when surveying in rough country, where curves are frequent and reversed. The type of transition curve used is the cubic parabola.

DESCRIPTION OF THE ROUTE ADOPTED.

Attached to this paper is a diagram plan and section, and I now proceed to give a short description of the location of the railway.

The railway leaves the Western Main Line at 86 miles 70 chains, the level of the rails at this point being 3611 feet above mean sea level. In general direction it follows a ridge or spur, which runs northward, and terminates in a bluff overlooking the Wolgan Valley, about 22 miles in a bee line from Clarence Siding.





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PLAN & SECTION OF

WOLCAN VALLEY RAILWAY

SCALES

HORIZONTAL MILES

VERTICAL FEET

H Deane 14.12.08

At 7 miles out, the top of the ridge is reached, at a level of 3960 feet above mean sea level, or about 350 feet above rail level at the commencement.

At this point there is a crossing loop, after passing which, the line begins to descend on a gradient of 1 in 50. This grade is practically continuous as far as 12 miles 20 chains, where Murray's Swamp is crossed. There are some sharp curves on this section, as without them the cost would have been very high. As it is, the earthworks are not heavy.

At Murray's Swamp, there is a dead end siding, where the sawmill was originally placed.

From 12 miles 20 chains to 19 miles, the line is undulating in character, and there are very few exceptionally sharp curves.

At 19 miles, the station, named Deane, is reached, and here the rail level is about 3500 feet above mean sea level, thus showing a drop from the summit at 7 miles of 460 feet. The earthworks on this section are light.

Soon after passing 19 milles, the great drop into the Wolgan Valley begins. The line begins to descend from the ridge and enters the rugged valley of Penrose Creek. Between 21 miles 70 chains and 23 miles 10 chains the line takes the form of the letter "S." On the upper part of this double curve a tunnel of 5½ chains length is situated, and shortly after, where the line is located on the top of a cliff, the continuation of it is below, with a difference of level of 160 feet. The line now follows the creek, crossing from one side to the other as occasion requires, enters the second tunnel, which is 20 chains in length, and after traversing the lower end of Penrose Gorge for about 13 chains, it reaches the open valley of the Wolgan. Here it skirts for nearly half a mile the base of some high cliffs, and then continues along the slopes lying at the base of the extension of these cliffs, always on a grade of 1 in 25, till the bottom station is reached at 28 miles 40 chains. It is scarcely necessary to state that on parts of this section the earthworks are very heavy, and the construction was extremely troublesome, especially where the railway traverses the base of the cliffs, and where men had to be supported from above by ropes in order that the necessary action of jumping holes and using bars to lever out loose rocks might be effected. Under the circumstances, it would be misleading if any maximum height of cutting were given, but it might be mentioned that the height of the embankment at 23 miles 35 chains is 77 feet, and that between 24 miles 50 chains and 25 miles 50 chains there are several places where the toe of the embankment is from 100 to 150 feet below the level of the formation.

At 24 miles 10 chains a crossing loop has been provided. From the bottom station, at 28 miles 40 chains, the line skirts the East bank of the Wolgan River, following a generally Northerly direction as far as 30 miles 70 chains, where the township is situated, and where a passenger and goods station has been laid out. Here the river takes an abrupt turn to the East, and the railway follows the same direction, terminating with the works' sidings at about 32 miles 6 chains. The difference of level between the summit at 7 miles and the line in the valley is 2200 feet.

PERMANENT WAY.

An arrangement had been made with the Railway Commissioners by Mr. Sutherland for the purchase of good second-hand double-headed steel rails, 75lbs. to the yard, in 24 feet and 21 feet lengths, at a reasonable rate per ton, chairs and fish plates being given in free. This was a suitable arrangement, as second-hand flat-bottomed rails were not immediately obtainable in sufficient quantities, and if new ones had been indented they would have probably cost about £8 per ton delivered.

The 75 lb. double-headed steel rails were laid from the junction as far as 28 miles 60 chains, from which point 60 lb. flat-bottomed rails, of which about 450 tons were purchased in Tasmania, were laid down.

Where the 75 lb. double-headed rails have been used, nine sleepers have been inserted for the eight yard length, but for the flat-bottomed road, two extra sleepers, or eleven to the eight yard length, have been used.

Fish bolts and spikes for the 75 lb. rails were purchased from W. Sandford, Ltd., of the Eskbank Iron Works, and hardwood keys from Goodlet and Smith and the Kauri Timber Co., tenders having been previously invited for the same.

About 12,000 hewn sleepers were purchased, prices having been obtained by calling publicly for tenders. The rest have been cut at a sawmill erected at Murray Swamp for the purpose, there being a good supply of stringy bark timber available within a convenient distance. This enterprise proved a complete success, and good sleepers were obtained at a moderate price.

The formation width adopted both for banks and cuttings is 17 feet, a fall of 6 inches being given from the crown to the side. This is the standard for the New South Wales Railways, and thus the Newnes Railway is in this respect in no way behind, and a high-class line of railway has been built.

It was intended to dispense with the use of hard ballast under the sleepers, except on clay banks and in hard cuttings, and to treat the line in the same way as the unballasted lines of the interior; but a good deal of ballasting has been found necessary in some places. The available ballast consists of coarse