design of the wheel had to be completed before the balance of the work was taken up. About Oct. 1 it was possible to prepare an estimate of the weight of the complete plow, when it was found that it would greatly exceed the limits that had been allowed by the Bridge Department. The wheels, which were constructed at the Argus Shops, were by that time partly completed, so that it was necessary to revise all the other drawings and practically redesign the entire plow. In fact, there was hardly a pattern or a drawing that did not require making up anew, with the exception that the only alteration of the boiler was to shorten the barrel. In spite of this delay, the first plow was completed by the Montreal Locomotive Works on Jan. 8, 1911, and the second one a few days later, a remarkably quick piece of work in view of its size and every part being entirely new in design.

It is difficult to say whether these plows have proved entirely satisfactory in service. From the time they arrived in the mountains there has been no trouble with snow that would test their capacity. They have been run through a drift of hard packed snow about 250 yards long without slowing down, and pushed by one engine in place of requiring two, as would have been the case with the old plows. This indicates that they have ample power and steaming capacity. One of the C.P.R. western officers states that they will cut trees 4 ins. diameter, but they have not been tried on anything heavier. Last season the man in charge, while going through a cut, felt a jar and saw a car coupler which had been left in the drift, thrown out to one side. The only damage is reported to have been a semicircular piece about 2 ins. in diameter broken out of one of the blades. With these exceptions, it has been difficult to obtain any definite reliable information. The plows do, however, work exceedingly well. There is an entire absence of the noise and vibration which makes the operation of a bevel gear driven rotary so unpleasant. The plows are so strongly constructed that it is difficult to see how any obstruction could injure them, and from what experience has been obtained, it is expected that they will be of great assistance in keeping the road open under any conditions.

The only trouble that has been experienced is through derailment. When the track is badly heaved, one spring on an equalizer may be compressed until practically solid and thus change the actual fulcrum of the equalizer. This has been overcome by placing a seat between the springs and the equalizer to ensure a constant point of application of the load and placing springs between the truck frame and the supporting plates. These were required on account of the small amount the plow frame can be twisted. When supported on one side only the opposite side was found to be ¼ in. lower. This shows the stiffness of the frame construction and explains why additional spring movement was necessary to compensate for the irregularities of the track.

While during the past few years the tendency has been to depend on wedge plows rather than rotaries for the general work of clearing away snow, still the rotary is called on when the limit of the wedge plows is reached, and for work they cannot safely attempt. The energy and perseverance of the Leslies led to the practical development of the rotary snow plow, and they deserve a great deal of credit for furnishing the railways with a machine that has rendered winter operation possible.

The foregoing paper was read before the Canadian Society of Civil Engineers recently.

The Economics of Railway Location.

By W. F. Tye, M. Can. Soc. C.E.

When looking around for a subject my thoughts turn naturally to railway location, on which a great part of my professional career has been spent.

Transportation is one of Canada's greatest problems: our country is of vast area, the distances are great, the population sparse, and the traffic light; making the mileage and cost of railways high per head of population. On the other hand the growth of the country is and will continue to be rapid. A great problem is thus presented: how to build our railways that they may not be too expensive for our present requirements, and yet be capable of improvement to fit our future needs. Economics of railway location is, therefore, of even more than usual importance to Canada. The subject is so vast that it is only possible in such an address to touch its outer fringe; but it is so important to us all that even a few rudimentary remarks may be interesting.

While railways are built to serve the traffic requirements of the country, the immediate object of the promoters and builders is to make a profit, either on the construction or operation. This is undoubtedly true when built by private parties. When built by a government, it is with the end in view that the people may make money either directly through the operation of the railway, or indirectly by the reduction of rates. It is, therefore, of prime importance that the engineer, whether he be working for private parties or for a government, locate and construct the most economic road. The most economic road is not necessarily either the cheapest or most expensive, neither is it necessarily the one which may be operated at the least cost—it is in reality the one which is the most effective commercially, or the one which will enable its owners to transport the largest amount of traffic at the lowest cost.

In order to ascertain that a railway is most effective commercially, the features which underlie its commercial effectiveness should be understood. There are:—Gross earnings, operating expenses, and fixed charges; and are of importance in the order named. Gross earnings, which depend on the amount of traffic handled, is undoubtedly first. It is never advisable to build a railway unless there is or will be sufficient traffic to pay the operating expenses and the fixed charges, no matter how cheaply or how well it can be built.

In new countries, such as most Canadian railways are built through, there is rarely sufficient traffic in sight to justify the construction of a road, so the promoters—whether they be a government or private parties—must have faith in the project and must be able to justify to themselves, and to the investing public, the possibilities of paying dividends.

Engineers are sometimes, though rarely, consulted in the early stages of the project to report on the traffic possibilities of the route. The usual way is for the promoters to decide for themselves that a road between certain terminals is commercially desirable, and that there is or will be sufficient traffic on such a route to justify its construction. Engineers are then employed to survey and construct the road. The question should at once arise with the engineer—how the railway can be so located as to make it the most effective commercially, or how to get for the promoters the most profitable traffic. No matter how this problem is stated, it finally resolves itself into this:—if the promoters be private parties, how can the road be so located and built that the most interest can be earned on the money invested—or if a government, to transport the most traffic at the least cost? The answer in either case would be the same, for, if it is so located that it may handle the most traffic at the least cost, it will, if properly managed, make the most interest on the money invested.

The first problem the engineer has thus to face is how he can so locate the road between the given terminals as to get the most profitable traffic. The route which takes in the greatest number of towns, or which goes through the best land, if the country be unsettled, should be the first examined. A mistake frequently made is to locate the road within a mile or two of an important town in order to decrease distance or avoid expense. The cost of handling traffic is the total cost from the door of the consignor to the door of the consignee, and rates on that basis must be equal. The added charge for cartage is at times so large as to wholly destroy the business of the badly placed line and give it to a competitor more favorably situated, or if it be not wholly destroyed, the additional cartage and delivery charges eat up the profits.

Where traffic is light, and train loads less than the rated capacity of the locomotive, the cost of handling additional traffic is much less than is the ordinary train mile cost. It should be figured in equating the value of a change in location which increases traffic at 50% of the usual train mile cost. In this respect it should be remembered that deviations from the direct route do not always materially add to the length of the line.

In order to locate a railway so that it may be commercially effective it is first necessary to know what the volume of traffic is likely to be, whether it is immediately available, and at what rate it is likely to grow. The best way to ascertain this is by comparison with roads through the same or a similar country. A road through a country most nearly approximating that to be traversed should be selected for examination, and its traffic for previous years studied. If, for any reason business is likely to be materially greater or less than on the road under examination, due allowance should be made.

All railways are now required to make yearly reports to the government, and such statistics should be examined as well as those published in the railway companies' annual reports. The average train load and the ruling grade should be studied, and finally the average number of trains per day should be ascertained. It must be remembered that though the traffic is rarely balanced, that is, that there is seldom as much tonnage moving one way as the other, the number of trains each way must within narrow limits be the same. It is not always easy for an outsider to ascertain the number of trains over any given railway, as railway statistics are not published in this form, but every effort should be made to arrive at it as closely as possible.

Having obtained this information, and having determined how the traffic on the proposed road will compare with that on the road under examination, some approximation of the ruling grades on the road in view should be arrived at. If different from those on the route with which comparison is being made, the number of trains per day each way on the proposed road should