APPENDIX F.

MIDLAND RAILWAY.

REPORT OF ENGINEERS ON ADHESION LINES OBTAINABLE OVER ARTHUR'S PASS.

MEMORANDUM for Hon. MINISTER for PUBLIC WORKS.

WE have now the honour to report as under on the question you have referred to us—namely, the possibility of obtaining an adhesion line of railway from the Otira Station to the Bealey Valley, in place of the Fell line, already approved.

As one of the conditions for concessions made to the Midland Railway Company, all the grades, except one on the constructed line, are now 1 in 60, instead of 1 in 50, as originally proposed. The 1-in-60 grades are all in comparatively short sections, and the curvature is good; there is only one 10-chain curve on the 1-in-60 grade and a few 15-chain curves. There is one short length of 1-in-56·6 grade with a 20-chain curve, near Stillwater. This was to have been flattened by the company, but was not; it can, however, be done at any time at a small cost. When this and some other minor and inexpensive improvements in alignment are made, the resistance to eastward haulage should not be worse than 1 in 57½ on the straight, after making allowance for the curvature resistance on the 1-in-60 grades. It will therefore be assumed as a basis of this report that the virtual ruling gradient, Stillwater to Otira and Bealey to Springfield, will be 1 in 57½, equivalent to the actual ruling gradient, plus curvature resistance.

It is necessary to assume that a certain volume of traffic will be taken over the line every year in order to compare the relative merits of the many possible alternative lines. For the purposes of this report the volume of eastward traffic is taken at 150,000 tons, and 50,000 tons westward, as it was in the former discussions on the Lake Brunner deviation and on the Abt *versus* the 1-in-50 adhesion line. The annual cost of working of each of the lines considered has been deduced from the above eastward volume of traffic, the engines being supposed to be fully loaded up the 1-in-60 grades, and the number of trains westward in a year being taken to be the same as the number east, though the engines will not be fully loaded on the 1-in-50 westward grades. The nature of the expected traffic is such that it may reasonably be taken that the engines, as a rule, will be very fully loaded going east. If the above volume of eastward traffic is assumed to be carried in partially loaded trains, the lines with the greater length will compare less favourably than they do with the shortest line in the table given below.

The question resolves itself into finding the best gradient to adopt between Otira and Bealey, so as to get the safest line at a reasonable cost, taking fully into account the probable traffic and the nature of the country through which the line must pass, and at the same time get a line of such a character that the combined annual cost for working-expenses and interest on cost of construction shall be the least possible.

To reduce the working-expenses of the Otira–Bealey section to a minimum it is necessary to get a line of minimum length and curvature over which the full train-loads that the heaviest New Zealand locomotives can take up the 1-in-60 grades can be hauled either (*a*) by these locomotives alone, or (*b*) by special locomotives of a more powerful class, or (*c*) by the single heavy locomotives aided by a single assistant engine to each train.

The alternative (*a*) would require a continuous 1-in-60 grade, with curves no worse than on the existing 1-in-60 grades, or equivalent grades on the straight. The great first cost and the high working-expenses of such a line, as given in the attached table, shows that it is not advisable to adopt a 1-in-60 grade. The alternative (*b*) could only be considered for grades nearly 1 in 60, and fails for similar reasons as (*a*); and it only remains to consider fully the possibilities of alternative (*c*).

Two ordinary locomotives of equal tractive-power, under equal conditions as to adhesion, will take the same load up a grade of 1 in 31 (about) on the straight which one alone could haul up a 1-in-60 grade with, say, 30-chain curves; and if specially heavy and powerful assistant engines were used somewhat steeper grades than 1 in 31 could, theoretically, be adopted. If sufficient saving in first cost and in working-expenses, due to length, &c., can be obtained by adopting a grade steeper than 1 in 60, to pay for the cost of working an assistant engine on each train, then the use of steep grades with assistant-engines becomes justifiable. A very full examination of a number of possible routes shows that by adopting steep grades, up to 1 in 37, through a tunnel, the shortest route between Otira and Bealey is obtained. The annual saving would be much more than the cost of the assistant-engine power required to work the steep grade, and the margin of saving is sufficiently great to justify the adoption of a steeper grade than 1 in 60. The steeper the grade, the heavier will the assistant engines require to be; but the increase in cost of working for the heavier engines can be but small, while the saving in length, due to the steeper grade, reduces the working-expenses and the interest on first cost so rapidly that it appears to be the best course to adopt the steepest grade the assistant engine can work. As, however, most of the steep-grade line would be in tunnel, in which, owing to condensation of steam, or moisture on the rails, or other causes, the adhesion may at times not be so good as on the line in the open, it is not advisable to adopt quite so steep a grade as the theoretical limit of 1 in 31 given above.