

we consider the engineering achievements in a country with such a relatively small population, it must be acknowledged that they have been on a transcendent scale. Several cities now well known in 1887 were either non-existent or very small. Toronto, for example, in 1793 had one solitary Indian wigwam, but in 1887 it had about 160,000 residents, and now contains about 500,000. The remarkable expansion of many of our cities has imposed great tasks upon engineers in the providing of roads, sewers, water supply, transportation and numerous other modern requirements.

#### Development of Highway Engineering

In an interesting history of Ontario roads, given in the 1914 report of the Public Roads and Highway Commission, it is stated that a military road system was carried out in Upper Canada by Sir John Simcoe in 1791, when the population was at least 10,000 souls. The first legislation in Upper Canada in connection with roads, was to appoint the justices of peace as highway commissioners to maintain roads by statute labor. Yonge street and Dundas road were laid in 1794, and roads from Kingston to Montreal, Montreal to Quebec, Newark to Fort Erie, were opened. The Queen's Rangers built bridges over the Humber and Credit rivers about 1798. York county has been the home of toll roads since 1833, and in 1889 an Act was passed to purchase them, but I believe some still remain. Good roads date from the passing of the Highway Act of 1901. The earliest reference to permanent roads which I have found is that a James Call constructed macadamized roads in Toronto in 1833. Canadian cities have built paved streets which will compare favorably with those laid elsewhere. A considerable mileage of good roads have been constructed in this province, but with the "enormous area, sparse population and monetary resources which, while not meagre, nevertheless have definite limits," this country has a task of great magnitude to undertake, and as indication of what it involves, it was announced in the press a week ago that the Ontario government proposes to build 1,600 miles of good roads this season. I observe that the Hon. F. C. Biggs, the Provincial Minister of Public Works, lays emphasis on the importance of a high standard of maintenance, which I believe to be a fundamental requirement in connection with good roads.

In 1887 there were 30 waterworks in Ontario, 28 in Quebec, 1 in Alberta, 2 in British Columbia, 7 in Nova Scotia and 5 in New Brunswick, making a total of 73. To-day there are about 540 waterworks in operation, supplying about 450 million gallons per day. The capital cost is about \$125,000,000, which is an index of the growth in that branch of municipal engineering activity.

#### Sewage Disposal and Electric Railway Progress

The problem of how best to dispose of sewage has been one of the usual difficulties in many places. Canada possesses many large rivers and lakes which are most tempting outlets for its disposal. Mr. Wililts Chipman, in 1912, read an interesting paper at the annual meeting of the Canadian Public Health Association, giving the history of several sewage works, from which I have extracted the following items: "The first practical attempt at sewage purification in Ontario was on the flat bed irrigation system at the London Asylum in 1888. The first municipal sewage works built in this country was at Kitchener in 1892, followed by Waterloo in 1894. Hamilton installed the first chemical precipitation plant with presses in 1896. Stratford and Kitchener were the first to have septic tanks, and in 1912 Vernon, B.C., possessed the first trickling filters. The first electric railways in this country were built in 1890 from Windsor to Walkerville, and from St. Catharines to Thorold, but there may have also been a short stub exhibition line to Toronto at that time. These were followed by four miles each at Victoria and Vancouver, and short lengths at one or two other cities. When these railways were introduced engineers considered it sufficient to allow six H.P. per car. To-day it is customary to allow about 70 H.P. for single cars, 140 for double cars and 300 to 500 for suburban cars. In 1898 it was considered good practice to assume nine miles as the maxi-

imum distance for electric street cars to run from the powerhouse. Official annual statistics in this connection were begun in 1901, when there were 674 miles of electric railways in operation in Canada, whereas there are now about 2,300. The capital invested amounts to about \$170,000,000 and about 500,000,000 passengers are carried annually.

#### Hydro-Electric and Steam Railways

When the Canadian Society of Civil Engineers was first established, hydro-electric power schemes were almost unknown in the Dominion, and it is estimated that not more than 200 H.P. were then generated. In 1890 the total was about 4,500 H.P., compared with at least 2,000,000 to-day, so that Canada stands well in the van of hydro-electric developments. The equivalent of this power in coal at 6 pounds per horse-power-hour is about 52,500,000 tons per annum, the value of which can be easily calculated. The standard dynamos in Toronto in 1890 were 40 light, 10 amperes, 48 volts. To-day the Hydro-Electric Commission of Ontario is arranging to instal 50,000 to 60,000 H.P. generators in connection with the Chippawa scheme. One authority in 1893 expressed the opinion "that the practical success of the scheme of supplying hydro-electric power from Niagara to Hamilton was doubtful. The fact remains that hitherto no transmission of electric power for 35 or 40 miles has yet been accomplished on a commercial scale." The Ontario hydro-electric scheme was advocated many years before it materialized, and to-day, with a capital expenditure of over \$90,000,000, it supplies 120 municipalities.

The first steam railway in Canada, known as the Champlain and St. Lawrence, was built in 1836, and was 16 miles long, from Laprairie to St. John. No other railway was built in this country for ten years, and the first railway in Ontario was that from Toronto to Simcoe, which was started in 1853. The Federal government commenced the Intercolonial before 1867, and the National Transcontinental in 1905. The Canadian Northern may be said to have started in 1889, though the name did not appear until 1899. The Grand Trunk Railway Co. was formed in 1853: these four railways, with a total capital of about \$1,300,000,000, now become the property of the people. The Canadian Pacific was formed in 1880, and by 1885, five years ahead of contract time, the railway from Montreal to Vancouver was laid. The first train to run between these two cities was in June, 1886. There were 12,000 miles of railways in 1887, compared with 39,000 miles to-day. The capital has grown from \$519,000,000 to \$2,000,000,000, and the number of passengers carried has increased nearly five times, and the freight nearly eight times in the same period. Important engineering construction was involved, including tunnelling, docks, harbors, workshops, depots and other works.

There are, of course, many hundreds of bridges in Canada. Robert Stephenson designed the Victoria tubular bridge over the St. Lawrence in 1854, and its superstructure was recently rebuilt to accommodate the traffic requirements. Quebec bridge is a monument of engineering daring and skill, and as it is the largest cantilever bridge in the world, it is worth recording that it was designed and built by Canadians. The Lethbridge railway bridge may still hold the record for length and height. The Saskatoon reinforced concrete bridge is so far the largest of its kind in Canada, but will be excelled by the Hunter street bridge, which is now being erected at Peterboro.

#### Irrigation Matters

In matters relating to irrigation I think engineers have some reason to be proud of their achievements. The Canadian Pacific Railway schemes are very large, and other schemes are now being contemplated.

With regard to inland navigation, I suppose the Sault Ste. Marie canal, built by the Hudson Bay Co. in 1797, was one of the first in Canada. One of the locks is fortunately preserved, and its dimensions are 39½ ft. long, 7½ ft. wide, and 9 ft. deep, exceedingly puny when compared to the present-day locks. The present canal at Sault Ste. Marie was begun in 1888, and finished in 1894 at a cost of approximately